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Rhodora

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Conducted and published for the Club, by

ALBION REED HODGDON, Editor-in-Chief

ALBERT FREDERICK HILL
STUART KIMBALL HARRIS
RALPH CARLETON BEAN
ROBERT CRICHTON FOSTER
ROLLA MILTON TRYON
RADCLIFFE BARNES PIKE
} Associate Editors

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Vol. 66 January-March, 1964 No. 765

1st no. of v. 66

CONTENTS:

Arthur Stanley Pease. *Ralph C. Bean* 1

Additions to the Flora of Inagua, The Bahamas. *Richard A. Howard and Henry F. Dunbar* 6

Notes on Papaver dubium and Camassia angusta. *G. S. Winterringer* 16

Nomenclatural and Taxonomic Corrections in Warea (Cruciferae). *R. B. Channell and C. W. James* 18

Needle Number in Red Pine. *Arthur H. Westing* 27

Publication Date for The Flora of Stoughton. *A. F. Hill, Charles Schweinfurth and Frank C. Seymour* 31

(Continued on Inside Cover)

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CONTENTS: — *continued*

Viola rafinesquii, the only Melanium Violet native to North America. *Jens Clausen, R. B. Channell and Uzi Nur* 32

New Elatine (Elatinaceae) Populations in the Southeastern United States. *Wilbur H. Duncan* 47

Diplotaxis tenuifolia in Illinois and Other Records. *Robert A. Defilipps* 54

Pollen Dimorphism in Heterostyled Oldenlandia umbellata. *Bir Bahadur* 56

Additions to the Wolf Islands Flora, 1963. *A. R. Hodgdon and R. B. Pike* 61

Fasciation in Empetrum nigrum. *R. B. Pike* 62

Chromosome Numbers in Races of Haplopappus divaricatus. *Edwin B. Smith* 63

A Systematic Study of the Genus Bahia (Compositae) *to be concluded. William L. Ellison* 67

Notes on the Genus Diamorpha (Crassulaceae). *Robert L. Wilbur* 87

Flora of Missouri *(Review). Albion R. Hodgdon* 92

Hydrastis Canadensis L., in New England *Leopold A. Charette* 94

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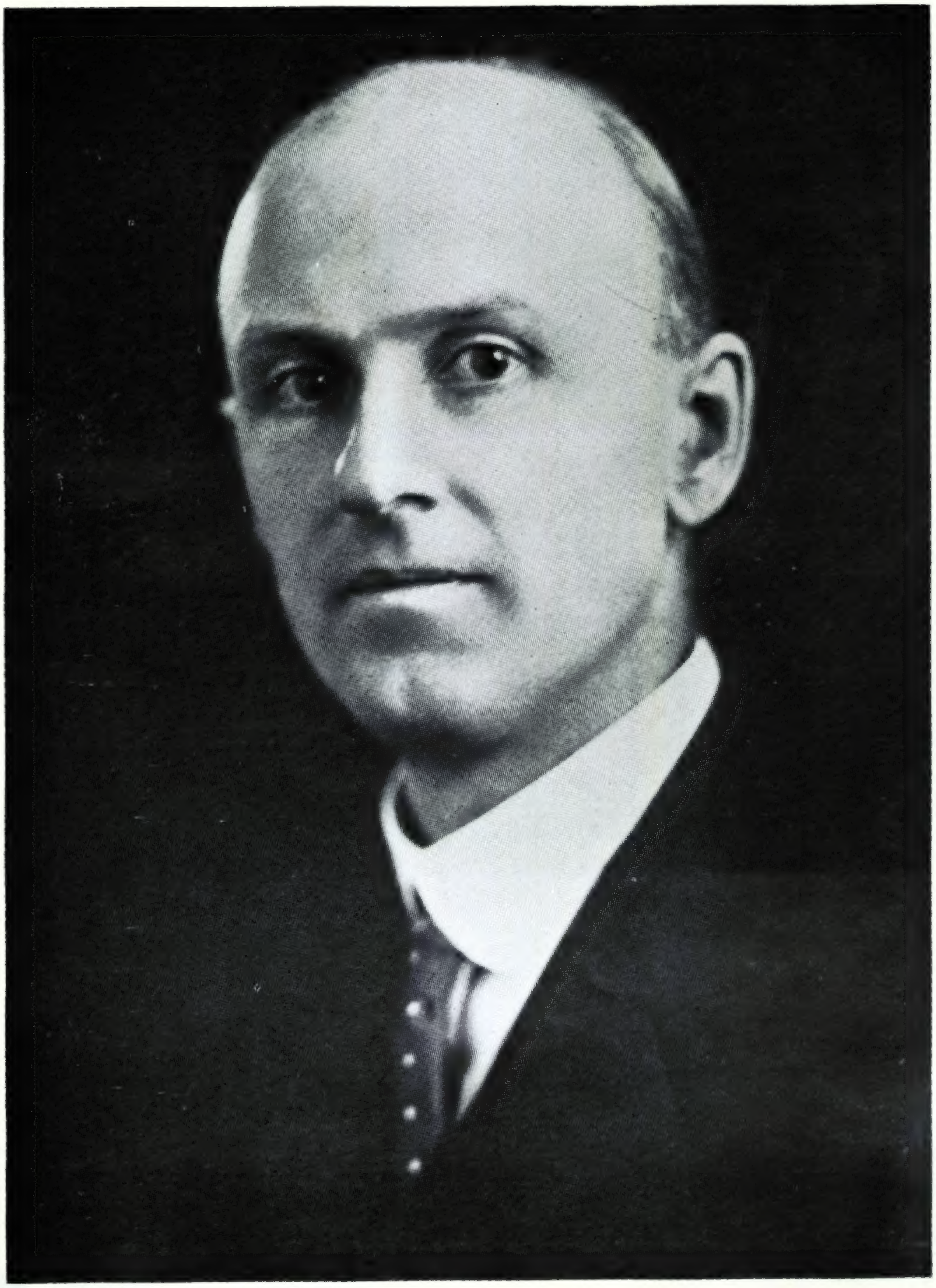
Scientific papers and notes, relating directly or indirectly to the plants of North America, will be considered by the editorial committee for publication. Articles concerned with systematic botany and cytotaxonomy in their broader implications are equally acceptable. All manuscripts should be double-spaced throughout. Please conform to the style of recent issues of the journal. Illustrations can be used only if the cost of engraver's blocks is met through the author or his institution. Forms may be closed five weeks in advance of publication. Extracted reprints, if ordered in advance, will be furnished at cost.



Arthur Stanley Pease (1881- 1964). Photograph taken in 1927.

Plate 1293

Rhodora

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ARTHUR STANLEY PEASE

It is seldom that classical scholarship and an enduring interest in systematic botany go hand in hand. However, these were the life interests of Professor Arthur Stanley Pease who died January 7, 1964, after a short illness.

Professor Pease was born at Somers, Connecticut, September 22, 1881, the son of Theodore Claudius and Abby Frances (Cutter) Pease. He fitted for college at Phillips Academy at Andover, Massachusetts, and while he lived in Andover he acquainted himself with the plants which grew there as well as with the flora of near-by towns in Essex County, Massachusetts. He graduated from Harvard in 1902, *summa cum laude*, received his A.M. in 1903 and his Ph.D. in 1906.

The following year, he devoted to travel and study abroad, spending most of his time in Italy and Greece. From 1906 to 1909, Professor Pease was instructor in Latin at Harvard and Radcliffe. In 1909 he married Henrietta Faxon at Cohasset, Massachusetts. There was one daughter, Henrietta, born July 14, 1912, who married Professor Sherwood L. Washburn of Berkeley, California in 1938.

Professor Pease was appointed Assistant Professor of Latin at the University of Illinois in 1909. He became full professor as well as the Curator of the Classical Museum.

He went to Amherst College in Massachusetts, in 1924, to become Professor of Latin, a position which he held until 1927, when he was elected President of Amherst College. He continued in this office for five years until 1932. His interest and taste were, however, in teaching and research, and he finally made the momentous decision to resign the

presidency of Amherst and return to his Alma Mater as Professor of Latin. He made this change in 1932, and in 1942, he was appointed Pope Professor of Latin at Harvard. He continued active teaching until his retirement in 1950 when he became Professor *Emeritus*.

But his retirement did not bring an end to his activities in his chosen field. In 1955 he published the first volume of an annotated text and critical edition of Cicero's treatise "On the Nature of the Gods." The second volume followed in 1958. More recently, during the last two years, he collaborated with Dr. Richard Evans Schultes of the Harvard Botanical Museum in writing a book on the Generic Names of the Orchids, which came off the press on the day of his death.

Professor Pease received honorary degrees from Williams, in 1931, and Amherst, in 1933. He was Trustee of Andover Theological Seminary and of the Loeb Classical Library. Over the years he was a member of various groups of classical scholars, among them the American Philological Association of which he at one time was President. He had also served as Vice-President of the American Academy of Arts and Sciences, as President of Phi Beta Kappa at Illinois, at Amherst and at Harvard, and as President of the Cambridge Book Club. He contributed many papers to classical journals.

But, to those interested in botany, it is Professor Pease's work in New England botany for which he will be especially remembered. He spent much of his time between semesters in the field in the study and identification of plants. He not only collected in New England, but, wherever he went, he was always alert in observing the plants of that area. He traveled widely in the United States and Canada, especially in Newfoundland, Gaspé and the Maritime Provinces, and in Europe as well. He contributed greatly to our knowledge of the plants of these regions. To the botanical friends who often went with him on these expeditions he proved a delightful traveling companion not only because of his knowledge of the plants but also because of his wide general interests and his inimitable sense of humor.

In his earlier years he had built up an herbarium of over

12,000 sheets which, in 1912, he gave to the Gray Herbarium and the herbarium of the New England Botanical Club. Each year thereafter the summer's collection would be added to these herbaria.

For many years Professor Pease had a summer home at Randolph, New Hampshire. He was an enthusiastic mountain climber and was for a time President of the Randolph Mountain Club. He was also a member of the Appalachian Mountain Club and had served as Vice-President. He contributed articles from time to time to *Appalachia*. He studied the plants of the White Mountains critically. This resulted in his publication in 1924 of "The Vascular Flora of Coos County, New Hampshire," which embodied his many years' study of the area. The same analytical mind which made him the keen critic of the Latin texts was used in the study and identification of the plants of the northern New Hampshire flora. This year there is being published an enlarged and much improved edition of this Flora which incorporates the result of forty more years of his study in the area. As he himself wrote, "Love of out-of-door life, particularly in the mountains, has proved an excellent balance to the professional indoor activities."

He was a long-time member of the New England Botanical Club which he joined in 1902 and served as President from 1934 to 1937. Articles by him appeared in *Rhodora* from time to time. His first article was in 1902 and the last in 1961. In addition to his contributions in his special fields, he published, in 1946, a book of essays "Sequestered Vales of Life."

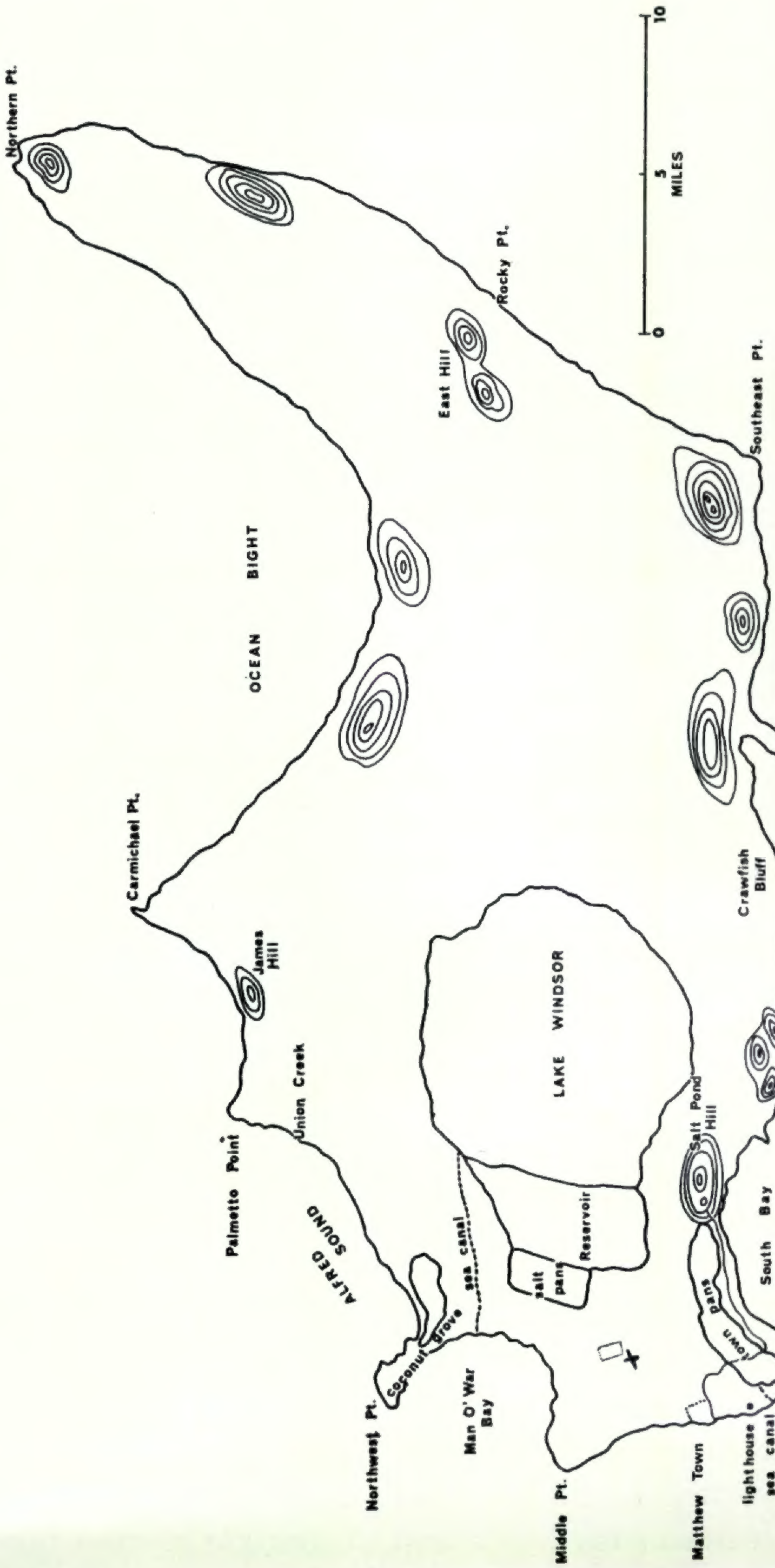
RALPH C. BEAN

ADDITIONS TO THE FLORA OF INAGUA, THE BAHAMAS

RICHARD A. HOWARD AND HENRY F. DUNBAR

In 1904 George V. Nash, accompanied by Norman Taylor, visited Inagua in the southern part of the Bahamas to collect specimens in support of the work of N. L. Britton. Nash reported (Jour. N. Y. Bot. Gard. **6:** 1-19. 1905) the islands as "botanically unexplored previous to our visits" and supplied a good description of the vegetation and a map with local place names. Nash's transportation was limited to horse and carriage, and short jaunts on foot from points reached by small coastal boats. He stated "the flora here is not a large one, and the same species will be found repeating themselves time and again in different parts of the island, but in almost all the places at which we touched some few plants were found which we had not detected elsewhere, so that it would require a pretty thorough exploration of all parts to secure a complete representation . . ." Nash collected "over 1,000 specimens" which Britton and Millspaugh (Bahama Flora 653. 1920) indicated as 482 collectors numbers *(874-1138, 1258-1474)* from Inagua and 96 numbers *(1162-1257)* on Little Inagua.

Britton reported on the collections of Nash and Taylor, among others, in a series entitled "Contributions to the Flora of the Bahama Islands" (Bull. N. Y. Bot. Gard. **3:** 441-453. 1905. **4:** 115-128, 137-143. 1906). In these he described *Pithecolobium flavovirens N & T 1143, Cassia inaguensis N & T 910, Sarcomphalus taylori N & T 961, Opuntia nashii N & T 1063, Plumiera inaguensis N & T 960, Lycium spathulifolium N & T 1321, Coccolobis bahamensis N & T 1352, Caesalpinia reticulata N & T 1012, Heliotropium inaguense N & T 1293* and *Anastraphia cuneifolia* Greenman in Britton *N & T 1295* and *Marsilea nashii* Underwood in Britton *N & T 1411* all based on collections from Inagua. From collections made on Little Inagua Britton described in the same series *Bursera inaguensis N & T 1190, Heliotropium diffusum N & T 1221* and *Lantana*


GREAT INAGUA
Northern Pt.
OCEAN BIGHT
Carmichael Pt.
James Hill
Union Creek
Palmetto Point
ALFRED SOUND
Northwest Pt.
Coconut Grove
sea canal
Man O' War Bay
LAKE WINDSOR
salt pans
Reservoir
Middle Pt.
East Hill
Rocky Pt.
Southeast Pt.
Lantern Head
Crawfish Bluff
Conch-shell Pt.
Salt Pond Hill
South Bay
town pans
Matthew Town
lighthouse
sea canal
Southwest Pt.
0
5
MILES
10

balsaminifera N & T 1211. Subsequently other species, including one new genus, were described based on these collections and these included *Agave inaguensis* Trelease *N & T 21833, Agave nashii* Trelease *N & T 21855, Euphorbia lecheoides* Millsp. *N & T 1305, Heliotropium nashii* Millsp. *N & T 1011, Iresine inaguensis* Millsp. *N & T 1139, Nashia inaguensis* Millsp. *N & T 1006, Portulaca gagatosperma* Millsp. *N & T 1064, Varronia lucayana* Millsp. *N & T 1175* and *Dichromena inaguensis* Britton *N & T 1254.* It is of interest to record that of these 24 species, 20 are recognized by recent monographers. Millspaugh (Field Mus. Pub. Bot. 2: 141. 1906; 291. 1909) and Britton and Millspaugh (Bahama Flora 650. 1920) noted that Prof. J. T. Rothrock and Prof. Albert S. Hitchcock travelling together but collecting independently both had visited the island of Inagua for one day in the winter of 1890-1, and that Percy Wilson stopped at the west end of Little Inagua for one day in 1907. We have been unable to find any herbarium specimens representing collections made on Inagua since 1907. However, in the winter of 1961, one of us (HFD) had the opportunity to visit Inagua and to become interested in the vegetation. In the two succeeding winter seasons collections were made totalling 300 numbers. The present status of the island differs little from that described by Nash.

The Island of Inagua consists of an aeolian limestone in places consolidated into either hard or soft rock and in other places fragmented into sand and gravel. Much of the shore line is rocky, consisting of a very hard, chemically metamorphosed coral rock. Some ocean bluffs rise to heights of 30 feet. In other places there are long stretches of beautiful sandy beaches. Inland in flat areas some soil has accumulated among the rocks. On other islands such arable areas are called "black lands" but that term is not common in local usage on Inagua. Agricultural areas known locally as "farms" rarely exceed an acre in extent and are prepared by cutting off the shrubs and trees about a foot above their bases and then burning the area. This milpa

agriculture is referred to as "cut and burn" on Inagua. Crops usually consist of corn, several kinds of beans and peas, ochra, papaya, sweet potatoes, yams, squash, cabbage, tomatoes, lettuce and beets. The presence of both sisal and cotton plants suggests a former commercial type of agriculture. Some ruins of buildings are referred to as the "sisal plant." At present, however, the meagre subsistence crops probably provide but a fraction of the food consumed by any one family. At Northwest Point there is a large planted coconut grove, but most of the crop is consumed locally.

Scattered throughout the island are depressed areas up to 100 feet in diameter and 4-6 feet deep. These sinkholes presumably fill with water during rains but only a very few contain permanent water. *Nymphaea, Potamogeton, Chara* and *Neptunia* have been found in such ponds. *Acrostichum aureum* was found at the margins of one sinkhole between Matthewtown and Northwest Point. The sinkholes with an evanescent supply of water may have sandy bottoms devoid of vegetation with the margins occupied by various Cyperaceae, *Lippia, Marsilia, Echinodorus* and *Chara.*

Rainfall on Inagua is surprisingly uniform as indicated by monthly rainfall records maintained by the salt company. There is no regular wet or dry season although somewhat more rain is recorded in September, October and November. The average annual rainfall is between 25 and 35 inches. Rain storms are more frequent at Northwest Point than in the central area or that occupied by the salt ponds. The heaviest single storm recorded on Inagua occurred in June of 1960 when 18 inches of rain were recorded in one fall, setting back salt production by many months.

In the early 1940's the West Indies Chemical Company established a sea water evaporation industry north and east of Matthewtown, supplanting an old hand labor industry which had existed there for generations. In recent years an annual average of 250,000 tons of salt has been produced from 15,000 acres of evaporation area. Nearly the entire population of the island of 1400 persons is employed by the

salt company and lives in or near Matthewtown. The other settlements indicated by Nash have been abandoned. The salt company maintains a store and operates a boat service for its product between Inagua and southeastern U. S. ports. The Bahama airways supplies biweekly plane service from Nassau, and a small vessel operates between the Bahama islands on an irregular schedule.

Transportation around Inagua is limited. A dirt road extends approximately 30 miles along the south coast and a similar road runs a shorter distance along the north shore. A car with four-wheel drive is essential in many areas due to drifting sand.

The National Audubon Society maintains a warden on the island to observe and protect a large colony of flamingos present at Lake Windsor. The Bahama National Trust is engaged in building dams at the mouth of Union Creek in an attempt to raise turtles. This conservation project is jointly sponsored with the National Audubon Society.

Dunbar's collections do not include any new species. They do include many taxa which are not recorded previously from Inagua in Britton and Millspaugh's Bahama Flora. A few taxa are reported as new to the Bahamas or to the West Indies. Dunbar made an attempt to locate and recollect the endemic species described by previous authors. A study of these collections has permitted us to comment on Britton and Millspaugh's descriptions and keys, and to correct the nomenclature. The species cited without comment in the following list appear to be new records for the flora of Inagua. Voucher specimens are deposited in the herbarium of the Arnold Arboretum and some duplicates will be distributed.

MARSILEACEAE

Marsilea nashii Underwood. This taxon is based on collection, *Nash & Taylor 1411*, from Smith's Thatch Pond on Inagua. Underwood reported it to be "very abundant in sandy loam alternately dry and covered with a few inches of water. The species is remarkable for the compact habit of growth and for the extremely narrow leaflets which recall those of *M. tenuifolia* from Texas." Dunbar made an attempt to determine the variation in leaflet width and his numerous collections *94, 144, 157, 192, 235* show that leaflets vary from 2 to 5

mm. in width. Dunbar found this species in a score of places, thriving in surprisingly dry sandy soil; common near the upper edges of sinkholes and missing in places which are submerged for many months. In one area beyond Crawfish Bluff, plants of *Marsilea nashii* form a mat covering several acres.

TYPHACEAE

Typha domingensis Pers. *Dunbar 48A*. Recorded by Britton & Millspaugh as *T. angustifolia* L. but not from Inagua.

ALISMATACEAE

Echinodorus berteroi (Spreng.) Fassett. Fassett's revision (Rhodora 57: 133-156. 1955) recognizes two varieties, and Dunbar's collections *41, 244* represent the typical one. Britton and Millspaugh referred the Bahama plants to *Echinodorus cordifolius*, a species Fassett restricted to the United States. The collection *Dunbar 41* was made at the edge of a pond and had leaves narrowly lanceolate and acute at both ends averaging 6 cm. long, and a mature infructescence 13 cm. long. Collection *Dunbar 244* made in black muck and usually submerged, had leaves averaging 18 cm. in length with blades broadly ovate, rounded at the apex and truncate-cordate at the base. Fassett did not record this degree of variation in the plants he studied.

GRAMINEAE

Aristida ternipes Cav. *Dunbar 7*
Andropogon pertusus (L.) Willd. *Dunbar 3*
Cenchrus incertus Curtis *Dunbar 33*
Chloris polydactyla (L.) Sw. *Dunbar 37*
Paspalum laxum Poir. *Dunbar 6, 139, 186, 169, 202*
Paspalum molle Poir. *Dunbar 149*
Paspalum poiretii R. & S. *Dunbar 142*
Tripsacum dactyloides L. *Dunbar 196*. This species was "observed" on Inagua by Nash who thought its presence was "especially noteworthy." Apparently no specimen was collected or is preserved at the New York Botanical Garden. Dunbar's collection indicates the species persists on Inagua although it has not been found elsewhere in the Bahamas.

CYPERACEAE

Cyperus odoratus L. *Dunbar 114*
Dichromena colorata (L.) Hitchc. *Dunbar 18, 147*. Britton described *Dichromena inaguensis* based on *Nash and Taylor 1254* from Little Inagua. An examination of the type collection of this species and a comparison with the Dunbar collection suggests that the morphological characteristics used to distinguish the endemic species are neither significant nor reliable and it should be considered synonymous with *D. colorata.*
Eleocharis geniculata (L.) R. & S. *Dunbar 31*

AMARYLLIDACEAE

Agave inaguensis Trel. *Dunbar 50*. Formerly regarded as endemic to Little Inagua and South Caicos, this distinct species is now found on Inagua along with *Agave nashii* Trel. *Dunbar 185, 299*.

IRIDACEAE

Sisyrinchium exile Bicknell *Dunbar 145*. This is the first record from the Bahamas of the small yellow flowered species usually called *S. micranthum* Cav. Shinners, in his privately published journal Sida (1: 32-42. 1962), has pointed out that *S. micranthum* Cav. is a taller leafy stemmed species from Peru. *Sisyrinchium exile* is based on a specimen from Texas which was probably a ballast plant and its area of origin may be southern Brazil or northern Argentina. The occurrence of *S. exile* is as a waif in Inagua. Plants called *S. micranthum* collected at high altitudes in Hispaniola suggest further study of this "species" is needed.

URTICACEAE

Pilea microphylla (L.) Liebm. *Dunbar 209*. This ubiquitous plant has not been recorded previously from Inagua. The collection at hand represents the smallest leaf size of a species with a disturbing range of variability.

OLACACEAE

Schoepfia obovata C. Wr. *Dunbar 49*

AMARANTHACEAE

Amaranthus dubius Mart. *Dunbar 258*

Amaranthus viridis L. *Dunbar 201*. These two species are extremely rare in the Bahamas although they are weeds elsewhere in the West Indies. Dunbar's collections made in a vacant lot in Matthewtown represent the first records for Inagua.

Iresine inaguensis Millsp. *Dunbar 29, 199*. This unusual species with linear and sub-fascicled leaves is often thought to be of dubious rank. Dunbar's collections of many duplicates show little variation. The type collection *Nash & Taylor 1139* was made on Sheep Cay in Alfred Sound and a subsequent collection was made on Salt Pond Hill. Dunbar found the species at Northwest Point where plants were abundant on sandy soil and in the coconut groves.

LEGUMINOSAE

Caesalpinia ovalifolia Urb. *Dunbar 162*

Abrus precatorius L. *Dunbar 40*

Desmodium glabrum (Mill.) DC. *Dunbar 56, 159*. This species is listed by Britton and Millspaugh as *Meibomia mollis* but was not known from Inagua.

Parkinsonia aculeata L. *Dunbar 273*. An ornamental species commonly cultivated and escaped in the West Indies but extremely rare in the Bahamas and not previously recorded from Inagua.

RUTACEAE

Zanthoxylum fagara (L.) Sarg. *Dunbar 267*

POLYGALACEAE

Polygala wightiana Blake *Dunbar 176*

EUPHORBIACEAE

Croton eluteria (L.) Sw. *Dunbar 92*

Jatropha gossypifolia L. *Dunbar 256*

SAPINDACEAE

Cardiospermum microcarpum H.B.K. *Dunbar 64*

Meliococcus bijugatus Jacq. *Dunbar 282*. Dr. George Brizicky has pointed out to us that the original form of this name was altered to *Meliococca bijuga* by Linnaeus and so used by Britton and Millspaugh. Dunbar's collection is the first record from Inagua.

MALVACEAE

Cienfuegosia heterophylla (Vent.) Garcke *Dunbar 146*. This species has been recorded from the West Indies only from Cuba and Puerto Rico where it is regarded as weedy. This is the first record for the Bahama flora.

Thespesia populnea (L.) Soland. *Dunbar 275*

OLEACEAE

Jasminum fluminense Vell. *Dunbar 67*. Not recorded in Britton and Millspaugh from the Bahamas.

LOGANIACEAE

Polypremum procumbens L. *Dunbar 86*. This species was recorded by Britton and Millspaugh from Matthewtown on Inagua as the only location in the Bahamas and it still persists.

GENTIANACEAE

Centaurium brittonii Millsp. & Greenm. *Dunbar 20, 42, 214*

APOCYNACEAE

Plumeria obtusa L. var. *sericifolia* (C.Wr.) Woods. *Dunbar 286*. Reported by Britton and Millspaugh as *Plumeria sericifolia* and known only from Cuba and Inagua.

Rhabdadenia biflora (Jacq.) Muell. Arg. *Dunbar 203*. Recorded by Britton and Millspaugh as *R. paludosa* (Vahl) Miers but not from Inagua.

ASCLEPIADACEAE

Cynanchum inaguense (Vail) comb. nov.

Metastelma inaguense Vail, Bull. N. Y. Bot. Gard. 4: 142. 1906. Woodson and others have transferred many West Indian species of *Metastelma* to the genus *Cynanchum*. *Dunbar 98* and *207* are referred to this species which seems distinct. However, the genus is badly in need of revision.

HYDROPHYLLACEAE

Nama jamaicense L. *Dunbar 260*. Recorded by Britton and Millspaugh as *Marilaunidium jamaicense* (L.) O. Ktze. but not from Inagua.

BORAGINACEAE

Heliotropium diffusum Britton *Dunbar 106, 249.* The type of this species was collected on Little Inagua and the Dunbar collections are the first records for Inagua. Plants are abundant on Conchshell Point. *Heliotropium inaguense* Britton *Dunbar 277.* The distinctness of this species has been questioned but I. M. Johnston has indicated in unpublished notes in the herbarium that he regarded it as a good taxon. *Heliotropium nashii* Millsp. *Dunbar 191, 210.* This species was originally described as endemic to the vicinity of Matthewtown. Dunbar's collections indicate its distribution is greater than originally supposed on Inagua and that the plants persist as perennials, becoming dense cushion-forms.

VERBENACEAE

Nashia inaguensis Millsp. *Dunbar 82, 187.* Urban did not recognize this genus and transferred the species to *Lippia.* Both Moldenke and Alain, however, do distinguish the genus from *Lippia* and *Phyla* on the basis of the capitellate sessile or sub-sessile inflorescence and the cohering fruits. Dunbar's field notes indicate the plants appear to be restricted to an area within a mile or two of Matthewtown. He noted that the branches were commonly long and straggling with few if any lateral branches but that plants were found with the branches crowded with the twigs in four rows. In fresh material the fruits are smooth, shiny, spherical, of a translucent pale yellow color and shallowly longitudinally grooved.

SCROPHULARIACEAE

Scoparia dulcis L. *Dunbar 95.* This ubiquitous weed of the West Indies is of infrequent occurrence in the Bahamas and the present collection is the first record for Inagua.

MYOPORACEAE

Bontia daphnoides L. *Dunbar 272*

PLANTAGINACEAE

Plantago virginica L. *Dunbar 252.* The published local floras of the West Indies do not record this species although herbarium vouchers in the New York Botanical Garden indicate that plants have been collected in Bermuda and at Cinchona in Jamaica. Dunbar found *P. virginica* in abundance in flat land beyond Conch-shell Point with the plants growing mostly in the shade of bushes.

RUBIACEAE

Borreria savannarum Britton *Dunbar 177, 231.* Of the eight species of *Borreria* recognized from the Bahamas by Britton and Millspaugh, six are local endemics. An examination of the type specimens of the endemic species supports the distinctions used by Britton and Millspaugh. A study of Dunbar's collections of this and the following species clearly indicates a greater range of variation in pubescence

and suggests a re-evaluation will be necessary after further field study.
Borreria thymifolia Griseb. *Dunbar 105, 121, 170, 251, 278*
Erithallis odorifera Jacq. *Dunbar 179, 294.* Most recent manuals of tropical American floras have listed this species in the synonymy of *E. fruticosa* L. Britton did so in the Bahama Flora although he had recognized two species in his earlier papers. Recent studies on the other West Indian islands suggest two species are present and that *E. odorifera* comprises plants larger in size and leaf dimensions and possessing flowers with a strong odor. A number of morphological intermediates are available suggesting inbreeding populations which clearly deserve further field study.
Ernodea nashii Britton *Dunbar 217.* Britton and Millspaugh recognize six species of *Ernodea* in the Bahamas, five of them endemic to one or a few islands. The present species is a new record for Inagua but it is clear a field study is required to understand the specific limits in this genus.

CAMPANULACEAE

Lobelia lucayana Britton & Millsp. *Dunbar 150.* This species does not appear to have been collected a second time. Dunbar's collection is the first record from Inagua.

COMPOSITAE

Flaveria bidentis (L.) O. Ktze. *Dunbar 135.* Dr. Otto Solbrig kindly supplied the identification for this herbaceous widely branching plant of inland roadsides. The species is widely distributed in South America and this is the first record of its occurrence in the West Indies.
Gochnatia bahamensis (Urb.) comb. nov.

Anastraphia bahamensis Urb. Symb. Ant. 3: 415. 1903. Mr. Roy Jervis studied the genus *Anastraphia* and annotated many sheets to indicate it is synonymous with *Gochnatia.* Various authors have supplied many of the new combinations but the present one is needed. *Dunbar 280* is comparable to the type of *Anastraphia cuneifolia* Greenman from Inagua which Britton and Millspaugh have regarded as synonymous with *A. bahamensis.*
Salmea petrobioides Griseb. *Dunbar 109, 242*
Sonchus oleraceus L. *Dunbar 65*
Wedelia trilobata (L.) Hitchc. *Dunbar 190*
Tridax procumbens L. *Dunbar 261*

In addition to the flowering plants cited above Dunbar collected a moss *Barbula agraria* Hedw. *Dunbar 15* and two fungi *Pycnoporus sanguineus* (Linn. ex Fr.) Murr. *Dunbar 16* and *Xylosphaera dichotoma* (Mont.) Dennis *Dunbar 17* which have not been reported previously from Inagua. We are grateful to colleagues at the Royal Botanic Garden, Edinburgh, for these determinations.

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NOTES ON PAPAVER DUBIUM AND CAMASSIA ANGUSTA. These notes concern *Papaver dubium* L. and *Camassia angusta* (Engelm. & Gray) Blankinship in Illinois. Reference to *P. dubium* from Wabash County appears in Vascular Plants of Illinois (1955), and the same data are used in the Flora of Illinois, third edition, (1963). A record of this introduced European poppy is indeed mentioned by C. C. Deam in his Additions to the Flora of the Lower Wabash Valley, by Dr. J. Schneck (Proceedings of the Indiana Academy of Science, 1911). Deam says in this reference: "Papaver dubium L. In Shannon's lot. June 5, 1879". Wabash County is not specifically indicated. However, there is no reference to this plant in Schneck's Catalogue of the Flora of the Wabash Valley Below the Mouth of White River. (7th Annual Report, Geological Survey of Indiana, 1875). The author of this catalogue stated that most of the species listed were from Gibson and Posey counties in Indiana and Wabash County, Illinois.

Recent herbarium records of *P. dubium* in Illinois have been available for some time and these may be interesting. The flowers of this weedy poppy are fragile and ephemeral; and unless they are seen during early morning hours, the plants may escape casual observations. This writer notes that the habitat of all of these recent Illinois specimens is along the Baltimore & Ohio R.R. right of way in cindery soil at the edge of the railroad bed. All of the Illinois counties named below are traversed by this same railroad, but where the poppy appeared originally is not known. Collection data for recent records of *P. dubium* are: SANGAMON CO., between Rochester and Breckenridge, 7 June 1963, *G. S. Winterringer, 20827*. Two miles E. of Ashland, 2 June 1955, *G. S. Winterringer, 11720*. CASS CO., W. of Ashland, 25 May 1955, *G. S. Winterringer, 11719*, (Dup. at ILL). The plants in this last area had appeared annually, according to a local resident, for more than ten years. CHRISTIAN CO., near Edinburg, 7 June 1963, *G. S. Winterringer 20834*. (All specimens ISM).

Some authors prefer to regard *Camassia angusta* (En-

gelm. & Gray) Blankinship as a late flowering form of *C. scillioides* (Raf.) Cory. However the detailed description and treatment of *C. angusta* by J. A. Steyermark (See Brittonia **13**: 206-11. 12 April 1961) and collections and observations of this writer incline to support Steyermark. All of the Illinois plants are from the same area in Macon County. A recent discussion with Dr. V. H. Chase reveals that material from this area probably represents our only authentic collections of *C. angusta*. It should be noted that the habitat, along a railroad right of way, is in imminent danger of being destroyed. Collection data: MACON CO., S. of the village of Elwin, 31 May 1962, *G. S. Winterringer, 19001* and 7 June 1963, *G. S. Winterringer 20837*. (All specimens ISM).

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NOMENCLATURAL AND TAXONOMIC CORRECTIONS IN WAREA (CRUCIFERAE)

R. B. Channell and C. W. James

Errors in the treatment of *Warea* in Small's Manual (1933) were noted by us in 1958. After reviewing the taxonomy and nomenclature of the group and preparing corrections for publication, we discovered that our conclusions were in essential agreement with those published earlier by Payson (1923) in his monographic study of *Thelypodium* and its immediate allies. We had hence thought it inappropriate to publish our findings until recently, when a new name (*Warea auriculata* Shinners [1962]) appeared which we consider a synonym of the earlier available name, *Warea amplexifolia* (Nutt.) Nutt. It is our purpose to clarify the application of the latter name and to reconcile certain discrepancies in the taxonomic treatments of the genus.

The species in question was first described by Nuttall (1822) as "*Stanleya* ? *amplexifolia*, foliis integris ? amplexicaulibus, floribus corymbosis siliquis nutantibus." It was based upon material collected by N. A. Ware in the "arid pine forests" of "East-Florida." Accompanying the original description are the following observations, crucial to ensuing arguments concerning the application of the name: "Of this plant whose genus is consequently doubtful, we have seen only seeding specimens which Mr. Ware collected in the arid pine forests. The whole plant appears to have been smooth and glaucous, the stem terete, herbaceous, low, and branching towards the summit. With the radical leaves we are unacquainted, those few which remain on the stem are cordate-ovate, amplexicaule, and entire. The flowers have been aggregated in a close corymb; the peduncles are filiform. The siliques curved downwards, are conspicuously stipitate, flat and two and a half to three inches long, the stipe about three fourths of an inch, with the peduncle somewhat shorter. The dissepiment is equal and parallel with the valves. The seeds are alternately attached to either side of the suture of the dissepiment, and are small, brown,

oval, striated and compressed. The cotyledons are simple or undivided, and the radicle curved."

There is no reason to question either the "East-Florida" source of the type material of this species, as opposed to the northwestern arm of Florida where other Wareas are now known to grow, or to presume that Nuttall was at this time (1822) in the possession of a mixture of material from East and West Florida. The article in which the original description is published is entitled "A catalogue of a collection of plants made in East-Florida, during the months of October and November, 1821. By A. Ware, Esq." According to Nuttall, "The interesting fasciculus now collected by Mr. Ware, though made at an unfavourable season of the year, indicates the existence of a rich and varied Flora, and of a climate almost congenial to the cultivation of every important commercial production of the tropics." Such a statement would scarcely have been indicative of northern Florida, whether East or West, and leads to the supposition that the Ware plants were actually collected farther south in peninsular Florida. Such a supposition is borne out by the fact that a number of species listed in this "catalogue" are subtropical and reach their northern limit in peninsular Florida. Among these are:

Amyris floridana Nutt.	[=*A. balsamifera L.* ?]
Chiococca racemosa L.	[=*C. alba (L.) Hitchc.*]
Cyrilla paniculata Nutt.	[=*Ardisia escallonioides Cham. & Schlecht.*]
Passiflora Warei Nutt.	[=*P. suberosa L.*]
Plumbago floridana Nutt.	[=*P. scandens L.*]
Psychotria lanceolata Nutt.	[=*P. nervosa Sw.*]
Rhizophora mangle L.	

Other species listed in the catalogue which are not known to extend westward from "East-Florida" include:

Befaria racemosa Vent.	
Liatris fruticosa Nutt.	[=*Garberia heterophylla (Bartr.) Merr. & F. Harper*]

Piper leptostachyon Nutt.	[=*Peperomia leptostachya (Nutt.) Chapm.*]
Tillandsia Bartrami Nutt.	[=*T. utriculata L.*]
Tillandsia tenuifolia Sw.	[=*T. setacea Sw.* or *T. simulata Small*]

Furthermore, Nuttall records a *Maranta* seen by Mr. Ware "about the latitude of 28°," which is essentially that of Tampa, Lakeland and Winter Haven. The latter two cities are located in Polk County, one of only four East Florida counties in which an amplexicaul-leaved *Warea* is known to occur. Considerable credence is thus established for "East-Florida" as the intended meaning and for the peninsular source of the type material.

Nuttall's query and stated uncertainty concerning generic placement of the plant were resolved with the description by him of the new genus *Warea* in 1834. In this work the combinations *Warea cuneifolia* (Muhl. ex Nutt.) Nutt. (based on *Cleome cuneifolia* Muhl. ex Nutt. Gen. N. Am. Pl. 2: 73. 1818) and *Warea amplexifolia* (Nutt.) Nutt. were made. At this time, however, Nuttall lists the habitat of *W. amplexifolia* as "In West Florida", instead of "East-Florida." Between the time he described *Stanleya amplexifolia* from East Florida (1822) and the time he published the combination *Warea amplexifolia* (1834), Nuttall received additional material of *Warea* from West Florida, perhaps from Ware himself, since Ware was known to have collected in West Florida in the interim (cf: Nuttall's description, 1834, of *Chrysoma solidaginoides* from West Florida collected by Ware "several years ago"). There can be no question that Nuttall actually received additional specimens of *Warea* during this period, for his amplified description of *W. amplexifolia* (1834) is accompanied by observations of the flowers, which were not seen by him at the time of the carlier publication. Moreover, the plant illustrated in 1834 is clearly representative of a West Florida species (later described as *W. sessilifolia* Nash), not the one described from East Florida twelve years earlier.

It may be noted from the amplified description ("Foliia oblongo-ovatis semi-amplexicaulibus, siliquis ancipitibus

pendulis, *Stanleya amplexifolia,* Nuttall, in Silliman's Journal, vol. 5, p. 297. Plate 10.") that Nuttall referred appropriately to the leaves of the West Florida plants as "ob-longoovatis semi-amplexicaulibus" rather than "integris ? amplexicaulibus" as he had done when originally describing the species based only upon plants from East Florida. This reflects, it would appear, the difference in the two species. In the later account the calyx and corolla are both described as lilac purple, characteristic of *W. sessilifolia,* but not of *W. amplexifolia,* the sepals and petals of which are white or pink. It seems clear, therefore, that Nuttall, for whatever reason, regarded the West Florida material as conspecific with that of East Florida, since he clearly amplified the description of *Warea amplexifolia* to include the West Florida element.

The original description of the genus *Warea* was thus based upon three elements: *W. amplexifolia* (Nutt.) Nutt. (the type species of the genus), *W. cuneifolia* (Muhl. ex Nutt.) Nutt., and the then unnamed *W. sessilifolia* Nash.

Without specific reference to *Warea amplexifolia,* Nash (1896), fifty-two years later, resolved the problem by describing the plant of West Florida as representative of a new and distinctive species, which he named *Warea sessilifolia.* The original description of this species was based upon Nash's No. 2544 "Collected in the pine lands at Bellaire, about 4 miles south of Tallahassee, Leon County".

Impressed by the ". . . remarkably inconsistent descriptions that have been applied to the plant we have known as *Warea amplexifolia* . . . ", Small (1896), whose interest in the subject was renewed by Nash's description of *W. sessilifolia,* investigated the situation. Small pointed out the fact that Nuttall (1822) described *Stanleya amplexifolia* on the basis of eastern Florida specimens having amplexicaul leaves. Small observed further that Nuttall (1834) founded the genus *Warea,* at least in part, upon a plant from western Florida having merely sessile, non-clasping leaves. According to Small, Nuttall, ". . . failing to see that his *Warea amplexifolia* was different from *Stanleya amplexifolia,* com-

bined the original description of *Stanleya amplexifolia* with that of *Warea amplexifolia . . .*" Inasmuch as the amplified description of *Warea amplexifolia* (1834) was largely based upon the previously undescribed element of *western* Florida (a point already shown to be supported both by Nuttall's plate and notation "Hab. in West Florida"), Small assumed the western element to be the sole species intended by Nuttall by this name. Small apparently considered the actual species, *S. amplexifolia*, never to have been transferred to *Warea*. Small (1896) lists the binomial as "*Warea amplexifolia* (Nutt.)." which we interpret as Small's way of signifying his claim of credit for the transfer. Indeed, Small is listed as the author of the transfer in his *Manual* (1933). But, as Harper (1950) has pointed out, this represents "a somewhat questionable proceeding." Nomenclaturally, even if inadvertent, Nuttall's transfer was completely adequate, since the basionym was properly cited. That Nuttall used the name in a broad sense (including two elements) has no bearing upon the propriety of the transfer, the full author citation being "(Nutt.) Nutt."

Despite the evidence that Nuttall by 1834 was in possession of a mixture of East and West Florida material, Shinners (1962) maintains that Nuttall did not have a mixture. This presumptuous conclusion was reached after Shinners solicited the aid of Dr. Walter M. Benner in searching for the existence of authentic Nuttall material at the Philadelphia Academy and finding only one specimen named by Nuttall, a specimen with sessile leaves. "In other words", according to Shinners, "the only concrete evidence we have indicates that Nuttall did not have a mixture, and the only thing he did have was the plant shown in his illustration of *Warea amplexifolia* [a plant with flowers!]. This is identical with *W. sessilifolia* Nash, and the plant thought to be *W. amplexifolia* by Nash, Small, and Payson becomes *W. auriculata* Shinners, sp. nov.," notwithstanding the obvious conflict created with the original description of the type material of *Stanleya amplexifolia* as an avowed fruiting specimen, no flowers having been seen!

Shinners proceeded then to apply the Nuttallian epithet "*amplexifolia*" to the sessile-leaved West Florida plant (*Warea sessifolia* Nash) and to treat the conspicuously auriculate-leaved plant from East Florida as a new species, *W. auriculata*. Indeed, following Shinners, "Much more important than supposition is the question of what Nuttall actually had." In an effort to settle this issue the present writers requested the assistance of Dr. Norman K. B. Robson, of the British Museum, in locating a Nuttall type answering to the following description, which we supplied: "The type specimen of *Warea amplexifolia* (Nutt.) Nutt. (*Stanleya amplexifolia* Nutt.), if extant, is presumably at the British Museum. It was supposedly collected by A. Ware from the arid pine forests of East-Florida during the months of October and November, 1821. The specimen Nuttall described was a fruiting specimen (no flowers having been seen) and it had only a few upper leaves which were auriculate and clasping the stem." Dr. Robson has kindly aided us with the following reply: "Yes, there is a specimen of *Warea amplexifolia* (Nutt.) Nutt. in Nuttall's collection answering the description which you gave. It is labelled by Nuttall 'Stanleya or a n. Genus.* Stanleya amplexifolia. East Florida.' 'Warea' has been written later by him on a separate label. The specimen is mounted on the same sheet as a flowering specimen labelled 'Amplexicaul Stanleya' in other writing." Although the flowering specimen is obviously not a part of the type, we accept the fruiting specimen as the holotype and conclude that the application of the name *Stanleya? amplexifolia* Nutt. [*W. amplexifolia* (Nutt.) Nutt.] is clearly fixed in the sense of the *East Florida, amplexicaule-leaved* plant. We are thus in complete agreement with Payson (1923) who wrote in reference to *Warea sessilifolia:*

"This species, although quite distinct, has been confused with *W. amplexifolia* in the past. The illustration given by Nuttall (Jour. Acad. Phila.) to illustrate that species is evidently of *W. sessilifolia.* In this publication also the habitat is given as "West Florida." It would seem that Ware

collected both species but the one originally described as *W. amplexifolia* was from east Florida and in it the leaves were truly amplexicaul. That plant then must retain the name because of priority of publication. However, the plant that Nuttall really had in mind when he described the genus *Warea* was that described by Nash as *W. sessilifolia*."

The leaves of *Warea sessilifolia* were described by Nash (1896) as ovate and sessile. According to a note accompanying the original description, ". . . the ovate merely sessile leaves, not sagittate nor clasping as in *W. amplexifolia*, readily distinguish this plant from either of the other species." One would infer from this quotation that the leaves of *W. sessilifolia* are merely rounded and not auriculate at the base. However, we have observed that at least some, and in most specimens many of the leaves are auriculate. While the auricles of *W. sessilifolia* are quite inconspicuous and do not extend around the stem as in *W. amplexifolia*, the separation of these two species cannot be made on the basis of the mere presence or absence of auricles as Small's (1933) key would indicate.

The fourth species of the genus was described by Small (1909) as *Warea carteri* on the basis of material collected by Small and Carter (No. 831) in pinelands between Cutler and Black Point, Dade County, in southern peninsular Florida. This species is related to *W. cuneifolia* and, like it, has petiolate leaves. Small (1896, 1903) described *W. cuneifolia* as characterized by "pectinate-fimbriate" petal-claws, although these are smooth or nearly so as illustrated by Gray (1848). Small's original concept of *W. cuneifolia* was apparently based upon the then unnamed species *W. carteri*. Upon incorporating the latter species into the Manual, however, Small (1933) erroneously indicated both *W. cuneifolia* and *W. carteri* to be characterized by pectinate-fimbriate claws. This condition, perhaps more accurately described as conspicuously pubescent under magnification, with trichomes exceeding in length the width of the claw, clearly applies only to *W. carteri*, the claws of *W. cuneifolia* being smooth or only minutely pubescent under magnification, with very short, inconspicuous papillose trichomes.

The following key, adapted from that of Payson (1923) and Small (1933), incorporates the corrections noted in this paper.

KEY TO THE SPECIES OF *Warea*

1. Leaves sessile, the blades rounded or rounded-auriculate at base
   2. Leaves conspicuously auriculate, the auricles adnate, clasping the stem ..... *W. amplexifolia* (Nutt.) Nutt.
   2. Leaves inconspicuously or not at all auriculate, the auricles free, not clasping the stem ..... *W. sessilifolia* Nash
1. Leaves subpetiolate or petiolate, the blades cuneate at base
   3. Petal-claws conspicuously pubescent; gynophore shorter than pedicel ..... *W. carteri* Small
   3. Petal-claws smooth or merely papillose; gynophore longer than pedicel ..... *W. cuneifolia* (Muhl. ex Nutt.) Nutt.

Specimens from the five herbaria consulted in this study (DUKE, FLAS, GA, GH, VDB) indicate the distribution of the species to be essentially that listed in Small's Manual, but more specifically: *W. amplexifolia*, central peninsular Florida (Orange, Lake, Polk and Osceola counties); *W. sessilifolia*, panhandle of Florida from Leon County westward into Escambia County; *W. carteri*, south peninsular Florida from Polk and Brevard counties southward into Dade County; *W. cuneifolia*, from Liberty and Gadsden counties, Florida, northeastward through the Coastal Plain of Georgia and South Carolina into Harnett County, North Carolina.

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Literature Cited

Gray, Asa. 1848. Gen. Fl. Am. Bor. Illust. 1: 155, 156. pl. 66.

Harper, R. M. 1950. A preliminary list of the endemic flowering plants of Florida. Quart. Jour. Fla. Acad. **12**(1): 7, 8.

Muhlenberg, H. L. 1813. Cat. Pl, p. 61.

Nash, G. V. 1896. Notes on some Florida plants — II. Bull. Torrey Club **23**: 101.

Nuttall, T. 1822. A catalogue of a collection of plants made in East-Florida, during the months of October and November, 1821. By A. Ware, Esq. Am. Jour. Sci. **5**: 297.

———. 1834. A description of some of the rarer or little known plants indigenous to the United States, from the dried specimens in the herbarium of the Academy of Natural Sciences in Philadelphia. Jour. Acad. Phila. **7**: 83. pl. 10.

PAYSON, E. B. 1923. A monographic study of *Thelypodium* and its immediate allies. Ann. Missouri Bot. Gard. **9**: 311-315.

SHINNERS, L. H. 1962. *Warea auriculata* instead of *W. amplexifolia* of Small (Cruciferae). Sida **1**: 105, 106.

SMALL, J. K. 1896. Studies in the Botany of the southeastern United States — VII. Bull. Torrey Club **23**: 409.

———. 1903. Flora Southeastern United States, p. 487.

———. 1909. Additions to the flora of peninsular Florida. Bull. Torrey Club **36**: 159.

———. 1933. Manual of the Southeastern Flora, p. 573, 574.

NEEDLE NUMBER IN RED PINE

ARTHUR H. WESTING

Dendrology manuals and other texts list red pine (*Pinus resinosa* Ait.) as a two-needled pine. While the overwhelming number of fascicles do consist of the expected pair of needles, both infra- and supernumerary fascicles do occur. An indication of their frequency and distribution was obtained by an examination of ten healthy, 5-year-old, open-grown seedlings and 230 healthy, dominant trees 30 to 45 years old.

The ten five-year-old seedlings (2-1 transplants) averaged 51 cm in height and 14 mm in basal diameter. Each living fascicle was inspected, the total number of fascicles for the ten trees being 13,188. Of these 12,913 consisted of two needles, 252 consisted of three needles, 22 consisted of but one needle, while the remaining fascicle was made up of four needles.

The fascicles aberrant in number consisted of apparently normal mature leaves and were all enclosed in sheaths. Those consisting of one needle were circular in cross section; those consisting of three or four had needles more or less equal in size and shape and were circular or somewhat elliptical in combined cross section.

The aberrant fascicles found in the seedlings were restricted largely to a small zone at the distal end of an internode (i.e., stem section between branch whorls). Thus, 91% of the singlets, 61% of the triplets, and the lone quadruplet were found immediately subjacent to terminal buds (or where they had been grown past). While 15% of the three-needled fascicles were distributed more or less at random, the remaining 24% of the three-needled fascicles were found in a secondary area of concentration, a small zone at the proximal end of many of the internodes.

The 230 30-to-45-year-old trees inspected were plantation grown, had an average age of 38, and averaged 24 cm in diameter at 137 cm and 16 m in height. Thirty-six fascicles were sampled at random near the top of the crown from

each of the trees. Of the 8,280 fascicles thus inspected, all consisted of 2 needles except for two which were made up of three needles. These wer found subjacent to terminal buds, one on a 38-, the other on a 41-year-old tree. The data for the two age classes are summarized in Table 1.

Table 1. Fascicular needle number in *Pinus resinosa*

Number of Needles per Fascicle	*Frequency per 10,000* Age 5	Age 30-45
One	17	0
Two	9,791	9,998
Three	191	2
Four	1	0

Fascicular needle number, particularly amongst the different species of hard pines (Subgenus *Diploxylon*), is more or less variable and is more or less readily influenced by internal and external conditions.

That fascicular needle number is under the genetic control of multiple genes is indicated by the intermediate frequency distributions reported by Keng and Little (1961) for several intrasubgeneric hard pine hybrids. An examination of the two- and three-needled ponderosa pine (*Pinus ponderosa* Laws.) by Weidman (1939) disclosed an increase in the proportion of binate fascicles in a west-to-east traverse of the species. He discovered this to be a case of ecotypic variation since seed collected from throughout this range and raised in one locality for 22 or more years maintained the numeration of its parental origin. Doak (1934-1935) surmised the paucity of four-needled fascicles within the pine genus to be explicable on the basis of an evolutionary disadvantage of quadrifoliar fascicles and presented certain evidence in favor of this theory.

The present report has described the topophytic phenomenon of two zones of concentration of aberrant fascicles as well as the cyclophytic one of a lower frequency of aberrant fascicles in the older age class. Similarly, Ghent and Thomas (1960) reported for the predominantly two-needled jack

pine (*Pinus banksiana* Lamb.) that in young trees there is an area of concentration of three-needled fascicles subjacent to terminal buds, the frequency of these decreasing markedly with age. Haller (1962) found that predominantly three-needled ponderosa pines had a much higher frequency of two needles when young.

Certain more or less extraordinary developmental phenomena also give rise to aberrant needle numbers. Thus Ghent and Thomas (1960) reported a higher frequency of three-needled fascicles for the lammas shoots of jack pine. Haller (1962) observed that the stunted lateral branches of two- and three-needled ponderosa pines produced a much higher proportion of doublets than robust principle branches. Doak (1934-1935) described a predominantly two-needled mature Austrian pine (*Pinus nigra* Arn.) exhibiting the unusual feature of a bole covered with epicormic branches. Of the first 439 fascicles examined at random from these epicormic branches, he found 281 to consist of 3 needles, 100 of 2 needles, 56 of 5 needles, and 2 of 4 needles. In the present study, the only two shoots of interfoliar bud origin that were found were on one of the young red pines and possessed a much higher frequency of three-needled fascicles (19%) than did their neighbors of normal origin (2%). Borthwick (1896-1900) described a two- and three-needled Austrian pine sapling with a leader unusual in that it had produced no laterals for two years. This terminal growth was additionally unique in bearing many four-needled fascicles. These quadrifoliar fascicles, unlike the one found in the present study, were heterophyllous. While three of the needles were of similar size and combined to form a circle in cross section, the fourth was shorter and plano-convex in cross section and was found to originate from a hypertrophied scale of the interfoliar bud.

Regarding external influences, Harlow and Harrar (1958) reported the rare occurrence of three-needled fascicles on shoots of red pine infested with tip moths (*Rhyacionia buoliana* [Schiff.]).

According to Doak (1934-1935) it is a common observa-

tion that pines when heavily fertilized, irrigated, or otherwise subjected to unusually favorable conditions will tend to produce simple leaves. Seedlings of the mostly three-needled longleaf pine (*Pinus palustris* Mill.) were noticed by Pessin (1937) to produce a higher frequency of two-needled fascicles when the nutrient medium is markedly deficient in phosphorus. On the other hand, Schneider (1913) in studying the morphology of 16 species of pine concluded that in many cases fascicular supernumeration was positively correlated and infranumeration negatively correlated with favorable nutrient conditions. Similarly, Goebel (1960) observed that nitrogen fertilization tends to increase the number of needles per fascicle in the two- or more often three-needled loblolly pine (*Pinus taeda* L.) to four or even five.

It would be of great interest to explore the hormonal relationships between fascicular needle number and such factors as tree age and position within the crown and also to delve into the physiological mechanisms whereby environmental factors such as mineral availability and insect attack can influence fascicular morphogensis.

I should like to express my appreciation to Irene B. Andresen and Barbara Z. Thoma for their part in examining the needles.

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Literature Cited

Borthwick, A. W. 1896-1900. On the development of quadrifoliar spurs in *Pinus laricio* Poir. Trans. Bot. Soc., Edinb. **21**: 150-153 + 1 pl.

Doak, C. C. 1934-1935. Evolution of foliar types, dwarf shoots, and cone scales of *Pinus* with remarks concerning similar structures in related forms. Illinois Biological Monographs, Urbana 13(3), 106 pp.

Ghent, A. W. & Thomas, J. B. 1960. Regularity in distribution of supernumerary needles on the terminal growth of young jack pine trees. For. Sci. **6**: 331-333.

Goebel, N. B. 1960. Personal communication, 9 Aug 60. S. Car. Agr. Exp. Sta., Clemson.

HALLER, J. R. 1962. Variation in needle number in *Pinus ponderosa*. Amer. J. Bot. **49**: 675-676.

HARLOW, W. M. & HARRAR, E. S. 1958. Textbook of dendrology, covering the important forest trees of the United States and Canada. N. Y. McGraw-Hill, 561 pp.

KENG, H. & LITTLE, E. L., JR. 1961. Needle characteristics of hybrid pines. Silvae Genet. **10**: 131-146.

PESSIN, L. J. 1937. Effect of nutrient deficiency on the growth of longleaf pine seedlings. New Orleans: Sth. For. Exp. Sta. Occ. Pap. No. 65, 7 pp.

SCHNEIDER, W. 1913. Vergleichend-morphologische Untersuchung über die Kurztriebe einiger Arten von *Pinus*. Flora, Jena 5 [N.S.]: 385-446 + pl. XV.

WEIDMAN, R. H. 1939. Evidences of racial influence on a 25-year test of ponderosa pine. J. Agricultural Research **59**: 855-887 + 6 pl.

PUBLICATION DATE FOR THE FLORA OF STOUGHTON

Due to an unfortunate oversight, the date of issue of The Flora of Stoughton, Massachusetts by Dr. Sidney Fay Blake was omitted. This work appeared on October 31, 1963.

A. F. HILL, CHARLES SCHWEINFURTH AND
FRANK C. SEYMOUR.

VIOLA RAFINESQUII, THE ONLY MELANIUM VIOLET NATIVE TO NORTH AMERICA

JENS CLAUSEN, R. B. CHANNELL, AND UZI NUR

While associated at the Biology Department of Vanderbilt University in the spring of 1961, the authors had occasion to study the annual wild pansy, *Viola rafinesquii* Greene, in the vicinity of Nashville, Tennessee, and to determine the chromosome number of local representatives of that species. The information obtained, combined with previously unpublished experiments by the senior author, now makes it possible to corroborate that this plant is an indigenous North American species, a member of the otherwise Old World *Melanium* section of *Viola*.

SEASONAL DIMORPHISM

The North American field pansy, *Viola rafinesquii*, shows a characteristic seasonal dimorphism that has generally been overlooked: its early spring flowers are chasmogamic and have moderately large, showy petals; as the season moves towards late spring and early summer the same plants bear cleistogamic flowers that have tightly closed sepals, small or no petals, and fewer anthers that empty their pollen directly into the stigma. This inconspicuous cleistogamic stage is frequently overlooked.

Whether or not chasmogamic flowers develop appears to depend upon the season in which the seedlings germinate. Viola Brainerd Baird (1942, p. 204), possibly referring to some of her father's experiments, reported that *Viola rafinesquii* bears closed flowers in great abundance through a long growing season. If the seeds germinate in the fall, the seedlings produce open flowers in the spring followed by closed ones, but if they are germinated in the spring only closed flowers are produced. This is a behavior typical of a vernalization mechanism, possibly triggered by winter chilling.

Under natural conditions *Viola rafinesquii* possesses a

regular alternating pollination system: most of the seeds are produced within the tightly closed late spring and summer flowers by self-pollination, but during the early spring season there is a flush of open, showy flowers, providing possibilities for cross-pollination. In this respect the North American field pansy differs from its ca. 50 Old World relatives among which cleistogamy has not been observed.

The seasonal dimorphism of *Viola rafinesquii* is as striking as that in the classical example of *V. mirabilis* L. of the *Nomimium* section. Both species carry their cleistogamic flowers on erect stems. In contrast, our North American stemless blue violets of the *Plagiostigma* section and the European *V. odorata* L. of the *Uncinatae* have no elongated aerial stems and carry their cleistogamic flowers on decumbent pedicels, tending to bury their seed capsules in the ground.

The changes that occur in the floral development from the chasmogamic to the cleistogamic stage are remarkably coordinated. The petals gradually disappear, the number of anthers is reduced, and the style changes its growth, placing the orifice of the stigma below the remaining anthers. In *Viola mirabilis* the senior author observed that it is the two anthers adjacent to the lower, aborted spur-bearing petal that remain, and only two of the four anther lobes of each function, reducing the number of pollen mother cells to approximately four per lobe. In contrast, in *V. rafinesquii* only one anther remains in the fully cleistogamic flower. This is the upper anther between the aborted two upper petals, and the style performs a corresponding twisting growth that insures the receptance of the pollen in the stigma under these conditions. It is noteworthy that violets of distinct sections have evolved such different solutions to cleistogamic fertilization.

In *Viola rafinesquii* the early spring and summer forms are so different that superficially they could pose as distinct species. Such seasonal difference of form has delayed a recognition of the true nature of the species and has resulted in a highly confused taxonomic history.

TAXONOMIC HISTORY

The earliest known collection of the North American field pansy is Clayton's *Viola* No. 527, listed as a descriptive polynomial in Gronovius' *Flora Virginica,* 1739-1743. According to Fernald (1939), Gray in 1839 established the identity of the polynomial and annotated the entry as *V. tenella.*

The North American pansy was originally named by Rafinesque in 1808 as *Viola tenella,* a *nomen nudum* (Med. Repos. New York 5: 538, 1808) designating a North American violet. In 1813 Muhlenberg (Cat. 26) also listed *V. tenella,* but he probably obtained the name from Rafinesque; he also used it in the same sense. During 1818 and 1819 Rafinesque travelled in Kentucky and adjacent states (Fitzpatrick, 1911 pp. 24-26), the central region of the American field pansy, and in 1819 he validated *V. tenella* (The American Monthly Magazine and Critical Review 4:191, 1819). By this time, however, Poiret (1810) had long ago used the binomial *V. tenella* for a Syrian relative of *V. kitaibeliana* R. et S.

Frederick Pursh (1814, I:175) listed this North American violet as *Viola bicolor,* a common pre- and post-Linnaean synonym for *V. arvensis* Murr. (1770). Pursh did not claim *V. bicolor* to be a new species. The name was adopted from Hoffman's *Flora Germanica* 2:170 (1807), where it applied to one of the many segregates of *V. arvensis* Murr. Pursh mentions (Preface, p. xiii) that his Compendium was published on the plan of Hoffman's *Flora Germanica.*

Neither did Pursh claim *Viola bicolor* to be an indigenous North American species. On the contrary, he states in I, p. 175, that it "nearly approaches *V. tricolor.* Specimens in the collection of A. B. Lambert, Esq. from Pallas' herbarium are the same with this species". These specimens were North-Asiatic (Preface xvi) and accordingly belonged to the *V. tricolor-arvensis* complex, not to the North American species.

Nuttall (1818, p. 151) provided more information about Pursh's species, which he catalogued as "*V. bicolor* ? Hoffm.

Fl. Germ. 2, p. 170 and Pursh I, p. 175" with the synonym *V. arvensis* Elliott. Nuttall's description fits the vernal form of the North American pansy, and he adds significantly: "Closely related to *V. tricolor*. Apparently native".

In order to understand the use of the epithet *Viola bicolor* one must keep in mind that botanical legislation is a recent procedure and that taxonomic usages were lax in the transition period following Linnaeus' introduction of binomial nomenclature 200 years ago. *Viola arvensis* and *V. bicolor* were considered synonymous and were commonly thought of as being only varieties of *V. tricolor* until the beginning of the present century.

The epithets "tricolor" and "bicolor" were originally used descriptively for the two color "varieties" of the European field pansy, namely *tricolor*, for the ivory-yellow-violet large-petaled form which became the type of the species of that name, and *bicolor*, for the ivory-yellow small-petaled form which eventually became *Viola arvensis*. The friend and frequent correspondent of Linnaeus, Albert Haller, had polynomially described the latter as "*V. bicolor. V. arvensis*, flore candido et luteo", meaning a violet of cultivated fields, having ivory and yellow flowers (Flora Jenensis, 1748, p. 287). Linnaeus himself (Sp. Pl. 936, 1753) used the binomial *Viola tricolor* for the species but listed the trinomial *V. bicolor arvensis* Bauhin as a synonym for *tricolor*. Murray (1770) recognized the ivory-yellow small-petaled form as a species, validating the epithet *V. arvensis* for it instead of *V. bicolor*. Nevertheless, *arvensis* continued to be considered a variety of *V. tricolor* throughout the next 150 years.

The long-established usage of the epithet *Viola bicolor* persisted, however, beyond both Linnaeus and Murray. In old herbaria one often finds the name *V. bicolor* appended to specimens of *V. arvensis* of both pre- and post-Linnaean age. Gilbert's *Flora Lithuanica* (1781), listing *V. bicolor*, continued the practice. Hoffman (1807) in his *Flora Germanica* included a description of *V. bicolor*, having no idea that in later botanical legislation this act would validate the epithet. Pursh (1814) innocently perpetuated this epithet for a North American species.

The name *Viola bicolor* has therefore been a long-persisting source of botanical confusion. In relation to the North American species it must be rejected as a later homonym for the illegitimate *V. bicolor* Hoffman and as a source of confusion.

During the Asa Gray period (Torrey and Gray, 1838, p. 143; Gray, 1858, p. 144) the American field pansy was generally assumed to be an introduced form of the European *Viola tricolor* L. var. *arvensis* (Murr.) D. C. Later on it was suggested (Gray 1875, p. 80; 1889, p. 81; and 1895, p. 204) that the variety seemed like a native plant, but it was still not legitimately named and was referred to as *V. tenella* Muhl.

Greene (1899) was the first to provide a valid, legitimate name for Rafinesque's pansy, sensibly renaming it *Viola rafinesquii*, and this has been its name until fairly recently. Greene was the first to call attention to the fact that the vernal and summer forms of this species are very different, and he also recognized the species as the only North American relative of the Old World pansy group of violets.

Ezra Brainerd (1908 in Gray's New Manual p. 587; 1911; 1913 in Britton and Brown II:562-563; and 1921:164) clearly distinguished between *Viola rafinesquii* as a native species, and *V. arvensis* and *V. tricolor* as species introduced to North America from Europe. The illustrations accompanying Brainerd's treatment of the three species in Britton and Brown's Flora clearly render the characteristic morphological differences; the *V. rafinesquii* figure closely resembles the Tennessee form of that species, whereas the color plate in the 1921 book is of a distinctly different Kansas form of the species. Gleason (1952) in the third edition of Britton and Brown's Flora also correctly distinguishes the three species.

Brainerd's taxonomic descriptions do not refer to the seasonal dimorphism of *Viola rafinesquii.* His writings indicate, however, that he was highly conscious of the biological significance of cleistogamy in many North American violets. He extensively grew his plants for observation and

experimentation. Viola Brainerd Baird (1942), possibly referring to her father's experiments, reported that the time of the germination of the seeds of *V. rafinesquii* determines whether a stage of open flowers will precede the cleistogamous one, as was discussed under seasonal dimorphism.

In contrast to Greene and Brainerd, Fernald (1938, 1951) concluded that *Viola rafinesquii* is not native of North America. He regarded it as an introduced form of *V. kitaibeliana* Roem. et Schult., a weedy species of central to southern Europe and west Asia that until about 40 years ago commonly was considered to be another variety of *V. tricolor*. Fernald was influenced by his keen field observations that *V. rafinesquii* is now a rapidly spreading weedy plant along roadsides in the southern states, east of the Rocky Mountains. This is undoubtedly the case, but weedy nature does not prove that a plant is a foreigner, as Shinners (1961) has pointed out. Many indigenous species thrive on disturbed soil and utilize the new opportunities provided by the activities of man.

Influenced by A. J. Wilmott of the British Museum, Fernald (1938) named the North American plant *Viola kitaibeliana* var. *rafinesquii*, suggesting that the plant had possibly changed since it arrived in North America more than 200 years ago. Fernald discussed minute ciliation characters as criteria of identity but was silent on the real important differences, such as cleistogamy. He failed to notice that his figure 1 of Plate 526 is of a large-petaled chasmogamic spring form, and figure 2 of a cleistogamic summer form of *rafinesquii*, whereas *V. kitaibeliana* has open flowers and petals that are even smaller than in *V. arvensis*. We agree with Shinners that plants similar to the Eurasiatic *V. kitaibeliana* have never been recorded from North America. Neither has the American *V. rafinesquii* ever been reported from Eurasia or North Africa.

Although Shinners (1958) adopted the name *Viola bicolor* Pursh for the American field pansy in his Dallas Flora, the discovery of the existence of the earlier homonym *V.*

bicolor Hoffmann has led him subsequently (1961) to resume the use of *V. rafinesquii* Greene. Shinners has presented convincing circumstantial evidence that the Rafinesque violet is native to North America, a point with which most students of the species will agree.

It is our purpose to present additional evidence in support of the native status of this plant.

DISTINCTNESS OF VIOLA RAFINESQUII FROM ITS EUROPEAN RELATIVES

Viola rafinesquii, V. tricolor, V. arvensis, and *V. kitaibeliana* are morphologically closely related and form a species complex. Typically flourishing under disturbed conditions, these species are all weedy in nature, although they also occur in undisturbed habitats.

The characteristic features of the four species of the *Viola tricolor* complex are presented in Table 1. *Viola rafinesquii* is unique among them in being seasonally dimorphic: its early spring flowers are open and have showy petals, but in late spring and early summer the flowers gradually become closed, having no petals or only rudimentary ones. The cleistogamic, inconspicuous but heavily fruiting stage is poorly represented in herbaria.

Viola rafinesquii differs also from the other three species of the *V. tricolor* complex by having slender stems, a character to which the earliest epithet, *tenella,* referred. It is further distinguished by roundish, almost entire basal leaves, and by pectinate, palmately divided stipules. The petals of its open flowers are twice as long as the sepals, slightly shorter than the petals of *V. tricolor* but much longer than those of *V. arvensis* and *V. kitaibeliana.*

The petal color of *Viola rafinesquii* is either bluish white or blue, and both color forms may occur in the same populations. Wild *V. tricolor* in contrast has violet-purple or deep yellow petals, and *V. arvensis* and *V. kitaibeliana* both have ivory petals.

Viola rafinesquii is a winter annual like *V. arvensis* and *V. kitaibeliana.* The weedy forms of *V. tricolor* are also

Table 1
Distinctions among the species of the *Viola tricolor* complex

Characters:	*V. rafinesquii:*	*V. tricolor:*	*V. arvensis:*	*V. kitaibeliana:*
Stem	slender	fairly robust	robust	fairly robust
Life duration*	annual	perennial and annual	annual	annual
Leaf dentation	almost entire	crenate	crenate	crenate
Lower leaves	rounded	ovate to elongate	ovate to elongate	rounded to elongate
Stipules	palmate-pectinate	palmate to pinnate	pinnate	pinnate
Flowers	chasmogamic, becoming cleistogamic	chasmogamic	chasmogamic	chasmogamic
Petal length	9 mm. becoming none	10-12 mm.	5 mm.	2-3 mm.
Petal color	bluish white or deep blue	violet purple or deep yellow	ivory	ivory
Pollination	outcrossing and cleistogamic	cross-pollinating	selfing	selfing
n =	17	13	17	7, 8, 12, 18, and 24 in plants morphologically similar.

*All annual forms are plants of disturbed soil and weedy in nature. Perennial forms of *V. tricolor* are plants of dunes and coniferous forests.

annuals, whereas its races from uncultivated habitats, such as coastal dunes and coniferous forests, are perennials.

Viola kitaibeliana and *V. arvensis* are both habitual self-pollinators; *V. rafinesquii* alternates between opportunities for cross-pollination and forced self-pollination, whereas *V. tricolor* is structurally prevented from self-pollination. The perennial dune form of *V. tricolor* suffers severely by inbreeding, but the weedy forms of that species are self-compatible and can be inbred similarly to *V. rafinesquii, V. arvensis*, and *V. kitaibeliana.*

Chromosomal and cultivation evidence — *Viola rafinesquii* has 17 pairs of chromosomes. This number was previously established for plants grown from seeds of the Brainerd stock furnished by Alexander Gershoy (Clausen, 1929, and Gershoy, 1934). The plants of this stock were morphologically identical with the Brainerd color plate (1921) based on plants from Baldwin, Kansas (Baird, 1942, pp. 204-205; p. 214).

Counts of $n = 17$, $2n = 34$, were made by Nur in 1961 from morphologically different plants from several localities in the vicinity of Nashville, Tennessee, specifically for the present paper (cf. Channell voucher specimen No. *8878*, VDB). The same number has now been reported from Texas by Walter H. Lewis (Shinners, 1961). The counts suggest that *V. rafinesquii* is chromosomally constant through three separate regions.

Viola arvensis happens to have the same chromosome number, $n = 17$ (Clausen, 1921, 1922), as *V. rafinesquii. Viola tricolor* has a different number, $n = 13$, and in Europe it hybridizes spontaneously with *V. arvensis* despite their differences in chromosome numbers (Clausen, 1921, 1922, 1931); the hybrids have reduced fertility and second generations have reduced vigor. *Viola arvensis* and *V. tricolor* are rare weeds in the eastern and the northwestern United States but natural hybrids between these and *V. rafinesquii* have not been reported.

In contrast with the constancy of the chromosome number in each of the former three species, the number is highly variable in *Viola kitaibeliana,* where plants of similar mor-

phology have $n = 7$, 8, 12, 18, and 24 chromosomes (Clausen, 1927, 1929, 1931).

In cultures, *Viola rafinesquii* is more specialized in its requirements than the other three species. The Kansas strain received from Gershoy in 1926 was grown for five successive years in the experiment garden of the Genetics Department of the Royal Agricultural College at Lyngby, near Copenhagen, Denmark, and during 1932-1934 in the experiment garden of the Carnegie Institution of Washington at Stanford, California. *Viola rafinesquii* was weak and grew poorly out-of-doors in Denmark and California, although it is an aggressive weed in the eastern United States. In both environments the plants exhibited distinctly dimorphic flowers.

By contrast, *Viola tricolor*, *V. arvensis*, and *V. kitaibeliana* were all highly vigorous, both in Denmark and in California, indicating adaptabilities outside their natural ranges not shared by *V. rafinesquii*. The differences in range of tolerance may be taken as ecological evidence that *V. rafinesquii* is distinct from the other three.

Evidence from crossing attempts — In 1933 a series of crossing experiments was performed at Stanford in order to ascertain the degree of genetic relationship between the Kansas line of *Viola rafinesquii* and its three supposed European relatives. Chasmogamic flowers of *V. rafinesquii* were used for the crossings. "Key lines" of the three European species were used, which in many previous experiments had proved to be good "combiners" (Clausen, 1931). All lines, except one, were crossed reciprocally, with several flowers of each line being used for the crossings. The combinations were as follows:

1766-1
V. rafinesquii
$n = 17$

- × Line 504, *V. tricolor*, Emmerlev, South Jutland, $n = 13$
- × 1765, "*V. kitaibeliana nana*" *V. nana* (D.C.) Corbiere Channel Islands, $n = 24$
- × Line 142, *V. arvensis*, Tysinge moor, Sjaelland, $n = 17$

(all reciprocally)

Line 52, *V. arvensis* × 1766-1, *V. rafinesquii*, $n = 17$ (not reciprocally)
Allindelille, Sjaelland,
$n = 17$

Only empty seeds were obtained as a result of crosses involving *V. rafinesquii*. In all other combinations the three European species produced abundant seeds, good F_1 plants, and usually fair-sized F_2 populations (Clausen, 1931). The *Viola rafinesquii* parent also produced many good seeds when selfed.

The failure of *Viola rafinesquii* to cross with any of these species is therefore of considerable significance. Unquestionably the four species are morphologically related, but at least the Kansas form of *V. rafinesquii* is apparently separated from the other species by strong genetic barriers.

Geographic and edaphic distribution — The prevailing taxonomic confusion makes it presently difficult to determine the range of *Viola rafinesquii* with certainty. It is a delicate plant that grows in patches and colonies, often exhibiting one color form alone (pale bluish white or blue) or both color forms together.

The species appears to range from New York into Michigan and into Indiana, and westward into Nebraska and Colorado. Southward it ranges through New Jersey into Florida and westward into Texas and Oklahoma. This is a large area for a single species and much larger than that of most of the species outside of the *V. tricolor* complex. The regional climate of the eastern United States contrasts sharply with the climate of western Europe and western North America, but it is sufficiently diversified to admit more than one climatic ecotype.

Edaphically, *Viola rafinesquii* is a species of fields and open woods, of roadsides and waste places. It occurs on sandy soils, sandy clay, on calcareous shale, and on limestone. Its ability to range from sand to limestone indicates an unusual range in edaphic tolerance. In Europe, *V. tricolor* is primarily limited to acid, sandy soils and *V. arvensis* to calcareous soils of high ph values, whereas hybrid colonies occur on soils of medium ph (Clausen, 1922). It is there-

fore to be expected that edaphically distinct ecological races may exist superimposed upon series of climatic races in this species.

Discussion — It is a puzzling situation that a single *Viola* species of the section *Melanium* is native to eastern North America, whereas the other 20 to 50 species of the section, depending upon the species concept (Becker, 1910), occur on the other side of the Atlantic Ocean and are primarily European. *Viola rafinesquii* occurs over an area approximately the size of that occupied by the major bulk of the chromosomally and morphologically highly variable European pansy species, yet it is relatively uniform. It also is the only species of the section that bears cleistogamic flowers.

The *Viola rafinesquii* chromosome number, $n = 17$, appears to be derived. It is a rare number in the genus but is repeated in Europe in the widespread *V. arvensis* and in three rare endemics, namely, *V. rothomagensis* Desf., endemic to limestone areas of northern France, and in *V. eugeniae* Parl. and *V. pseudogracilis* Strobl, both montane, narrow endemics of the central and southern Apennines of Italy (Schmidt, 1961).

The inconspicuous *Viola kitaibeliana* seems to be the chromosomally most primitive pansy species. It possesses a rather wide range of chromosome numbers but is morphologically uniform. Although having uniformly small ivory petals, it apparently possesses genes for most petal colors and petal sizes, but genetic studies have shown that these are suppressed by inhibitors (Clausen, 1931).

Certain evolutionary generalities are contradicted by the fact that the partially sympatric European species of the *Melanium* section have retained compatibility and the geographically highly isolated *Viola rafinesquii* acquired genetic isolation from its morphologically close relatives on the other side of the Atlantic Ocean.

Viola rafinesquii gives the appearance of a uniform, rather primitive species. It is not possible to determine whether in the long past it migrated from Europe and in that process diverged genetically from the other members of the section

or whether the progenitors of the section left it behind in a migration eastward. In any case, the Old World species of Section *Melanium* have obviously experienced a far more lively evolutionary flourish than the single survivor in the New World, which has not been able to colonize the region west of the Rocky Mountains.

SUMMARY

Viola rafinesquii is a native eastern North American species of the otherwise Old World section *Melanium*, the highly distinct pansy section of the genus. It differs from all other species of that section by having seasonally dimorphic flowers: its early spring flowers are open and have large and showy petals, whereas in late spring to early summer the flowers become cleistogamic and closed, having rudimentary to no petals. In achieving cleistogamy *V. rafinesquii* follows a pattern in reduction of anthers that differs from the classical example of *V. mirabilis*.

Viola rafinesquii has had a turbulent nomenclatorial history and at various times has been associated with each of three European members of *V. tricolor* complex. It is, however, morphologically distinct from all of them by a combination of many characters.

Viola rafinesquii occurs sporadically throughout the southeastern and central parts of the United States east of the Rocky Mountains. It extends over at least 10 latitudes and occupies habitats that range from sand to limestone. Within each climatic zone it takes advantage of man's activities, has become weedy, and is in the process of extending its range (Shinners, 1961). Beyond its natural climatic range it was unsuccessful in transplantation to Denmark and California. In contrast, its European relatives are more adaptable, growing successfully in the latter two areas.

Viola rafinesquii has n = 17 pairs of chromosomes, the same number as in *V. arvensis* and in the rare endemics *V. rothomagensis*, *V. eugeniae* and *V. pseudogracilis*.

Attempts to cross *Viola rafinesquii* with good combiners belonging to *V. tricolor*, *V. arvensis*, and *V. kitaibeliana*

were unsuccessful, although the three latter species easily cross with each other.

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References

Baird, Viola Brainerd:
1942. Wild violets of North America. Berkeley and Los Angeles. University of California Press. xv + 225 pp.

Becker, Wilhelm:
1910. Violae Europeae. Dresden. G. Heinrich. iv + 152 pp.

Brainerd, Ezra:
1908. *Viola in* Gray's New Manual of Botany. 7th Edition. New York, Cincinnati, and Chicago. American Book Co., pp. 579-587.
1911. The caulescent violets of the southeastern United States. Bull. Torrey Club 38:191-198.
1913. *Viola in* Britton and Brown's Illustrated Flora of the Northern United States and Canada. Second Edition. New York. Charles Scribner's Sons. 2:543-563.
1921. Violets of North America. Vermont Agri. Exp. Sta. Bull. 244; 172 pp.

Clausen, Jens:
1921 and 1922. Studies on the collective species *Viola tricolor* L. I. Bot. Tidsskr. **37**:206-221, 1921. II. Bot. Tidsskr. **37**: 363-416, 1922.
1927. Chromosome number and the relationship of species in the genus *Viola.* Ann. Bot. **41**: 677-714.
1929. Chromosome number and the relationship of some North American species of *Viola.* Ann. Bot. **43**:741-764.
1931. Cyto-genetic and taxonomic investigations on *Melanium* violets. Hereditas **15**: 219-308.

Fernald, M. L.:
1938. Noteworthy plants of southeastern Virginia. Rhodora **40**: 443-446.
1951. Gray's New Manual of Botany. 8th Edition. American Book Co., New York; pp. 1041, 1042.

Fitzpatrick, T. J.:
1911. Rafinesque. A sketch of his life with biography. Des Moines. The Historical Department of Iowa. 239 pp.

Gray, Asa:
1938. *In* Torrey and Gray's A Flora of North America. New York Wiley and Putnam. I; p. 142.

1858. Manual of the Botany of the Northern United States. 5th Edition. New York. Ivison and Phinney. p. 144.
1889. Idem. 6th Edition. Revised and extended by Sereno Watson and John M. Coulter. New York, Cincinnati, and Chicago. American Book Co. p. 81.
1895. Synoptical Flora of North America. Rearranged and revised by B. L. Robinson and M. L. Fernald. New York, Cincinnati and Chicago. American Book Co. I, Part I; p. 204.

GREENE, EDWARD L.:
1899. A fascicle of new violets. *V. rafinesquii.* Pittonia **4:** 9.

NUTTALL, THOMAS:
1818. The genera of North American plants. Philadelphia. 1:151.

PURSH, FREDERICK:
1814. Flora Americae Septentrionalis. London. White, Cochrane, & Co. I: 175.

SCHMIDT, ALEXANDER:
1961. Zytotaxonomische Untersuchungen an *Viola*-Arten der Sekt. *Melanium.* Ber. Bayr. Bot. Ges. **34:** 93-95.

SHINNERS, LLOYD:
1958. Spring flora of the Dallas-Fort Worth area, Texas. v + 514 pp. Southern Methodist University, Box 473, Dallas 5, Texas.
1961. *Viola rafinesquii:* nomenclature and native status. Rhodora **63:** 327-335.

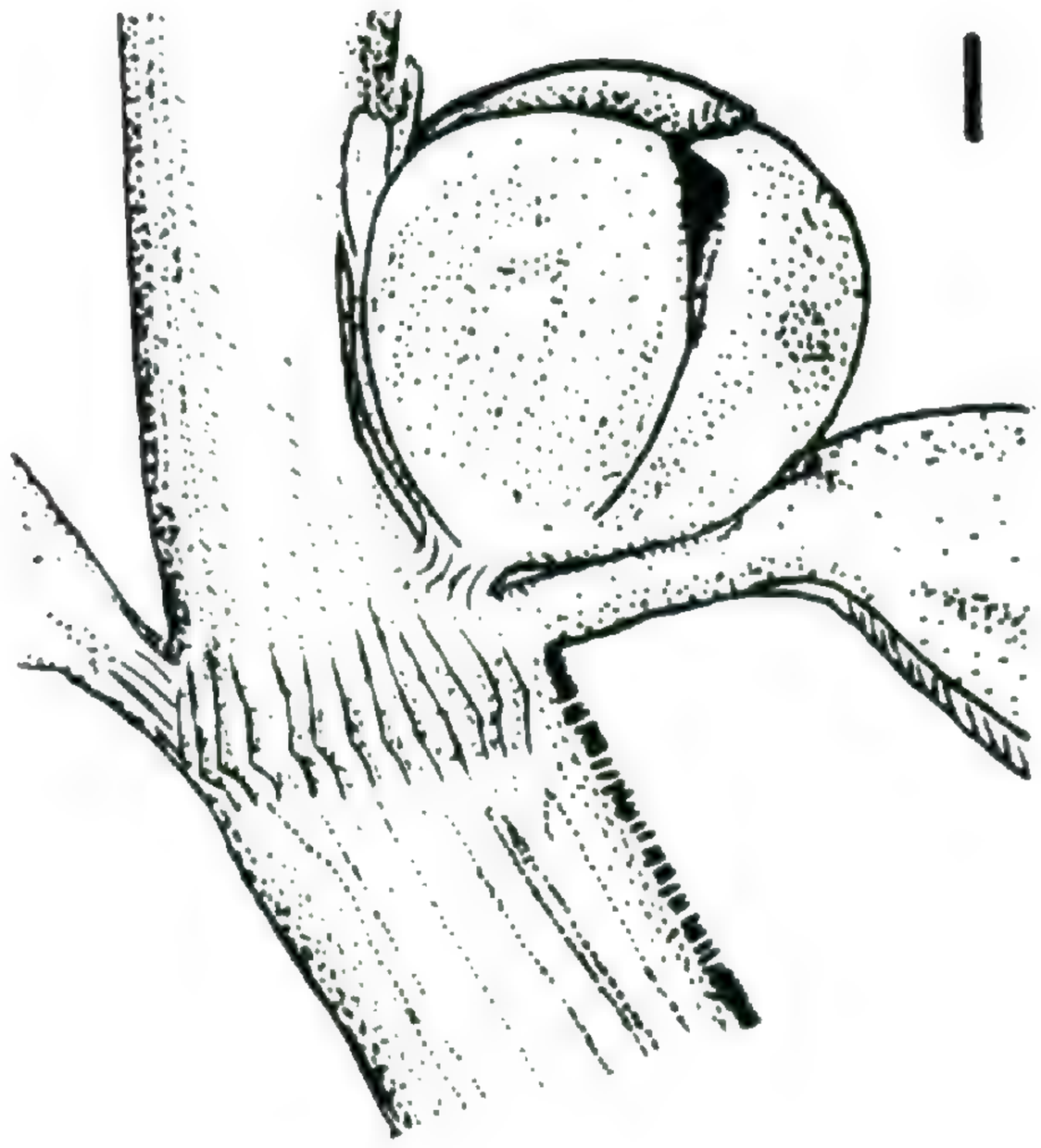
NEW ELATINE (ELATINACEAE) POPULATIONS IN THE SOUTHEASTERN UNITED STATES

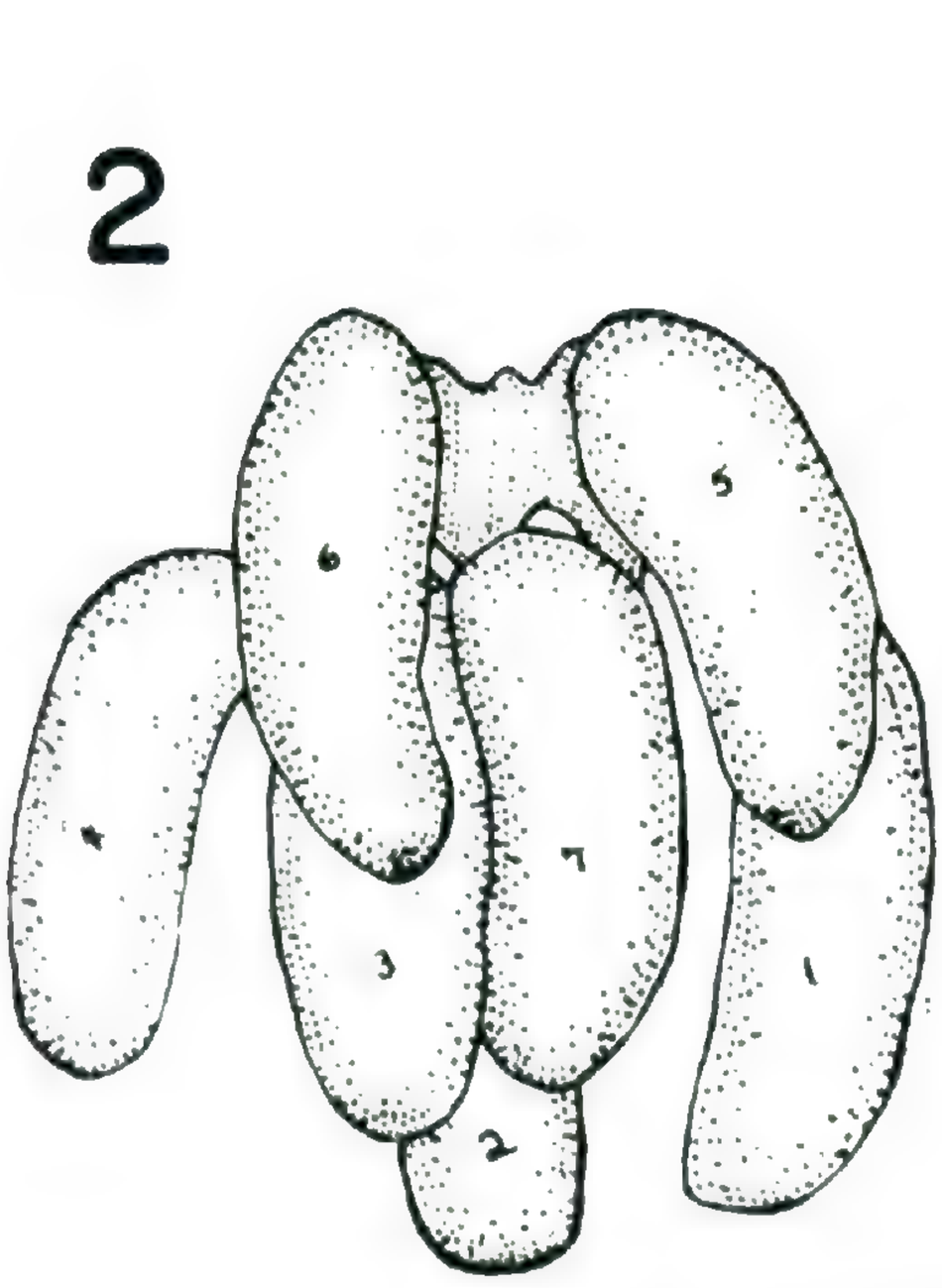
WILBUR H. DUNCAN

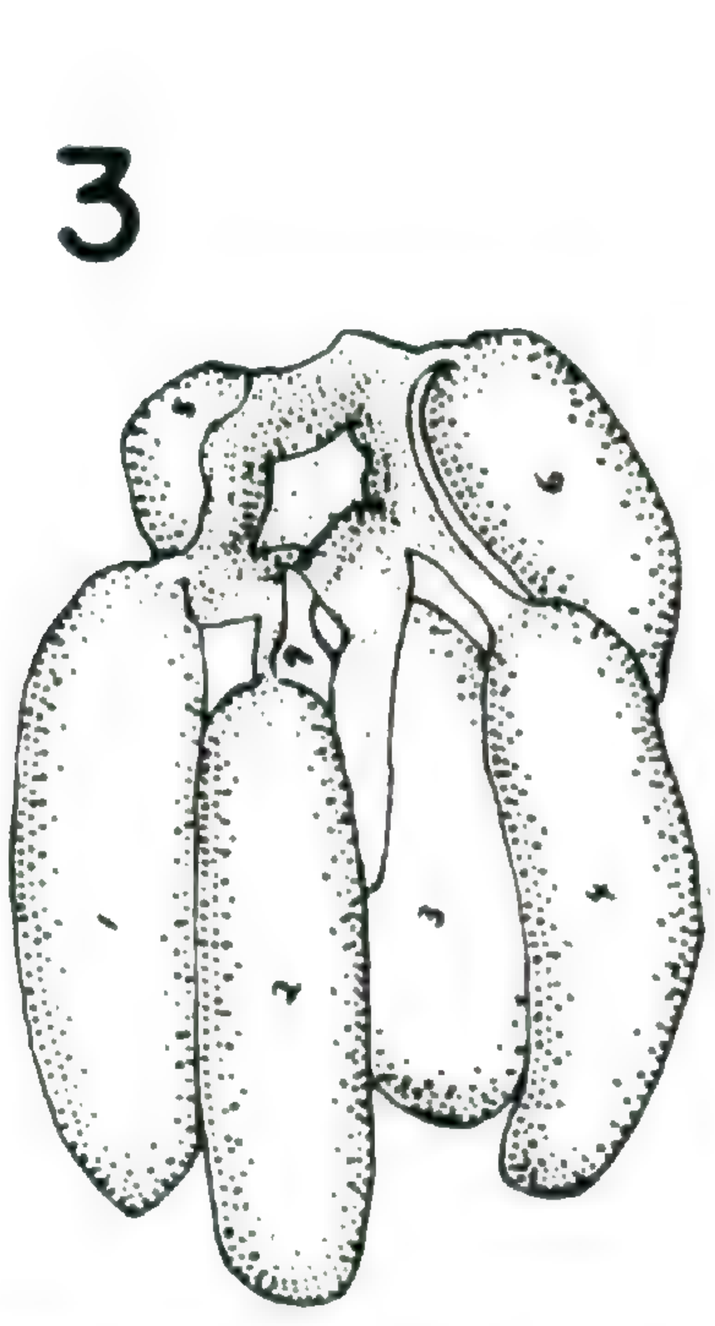
Literature to date indicates that *Elatine* is represented in the southeastern United States by *E. americana* (Pursh) Arn. which is reported for Tennessee by Small (1933) and Muenscher (1944) and for North Carolina by Small (1933), Muenscher (1944), and Radford (1951) who apparently missed the previous reports. Fassett (1939, 1957) reported no *Elatine* nearer to the southeast than Virginia, Ohio, or Illinois. Fernald's (1950) nearest reports are for *E. americana* and *E. minima* (Nutt.) Fisch. & Mey. in Virginia. Gleason (1952), however, acknowledges Small's report for *E. americana* for the southeastern states.

In 1960 Arthur Amerson, a student in a taxonomy class, brought in specimens of an aquatic which I identified from the meager material as *E. brachysperma* Gray. This collection was made on 8 May from a shallow pool of water on a granite outcrop 3.8 miles E27°S of Sparta, Hancock County, Georgia. The *Elatine* was associated with *Diamorpha cymosa* (Nutt.) Britton, a species characteristic of shallow soil of granite outcrops of the Piedmont Province of the southeast. On 28 October 1962 I collected abundant material of *Elatine* from a small pool of water in a depression of the granite outcrop at Echol's Mill 9.7 miles northeast of Lexington, Oglethorpe County, Georgia. The two sites are about 55 miles apart. Specimens from both sites are on deposit in the University of Georgia Herbarium. Additional material was collected at intervals from three pools at Echol's Mill during the following winter and spring and extensive studies made of all collections from Georgia and the few herbarium specimens on hand from other areas. Miss Jean Farr, an undergraduate major in Botany, ably assisted in these studies.

Live plants were observed at Echol's Mill during all months from October to June when the study was concluded. At some time during this period plants were found sub-







FIGURES 1-4. *Elatine triandra* from Oglethorpe Co., Georgia. Fig. 1. Mature fruit at node, × 20. Figs. 2-3. Opposing views of seven seeds attached to placenta from a single locule. Seeds are numbered for comparison, × 40. Fig. 4. Mature seed, × 50. Drawn by Jean Farr.

merged in water as deeply as 155 cm, emergent, or growing in moist soil. They were seen 0.8 to 46 cm tall (submerged), growing singly or in dense colonies, and unbranched to abundantly branched. Under such a variety of situations it was no surprise to me that leaf characteristics varied greatly. The extent of the variation was such that leaf characteristics used in keys to *Elatine* taxa by Fernald (1950), Muenscher (1944), and Fassett (1939) were of no diagnostic value. These observations support in part Fassett's (1939) contention that "Individuals of any species of *Elatine* grown under different conditions . . . resemble each other less closely than do individuals of different species. . . ."

The flowers of the Georgia material are three-merous and almost exclusively cleistogamous, most plants being submerged and the emergent ones flowering less abundantly. The fruits are all three-parted (Figure 1), three-loculed, and may attain a length of 1.5 mm. They apparently do not dehisce but rather the wall disintegrates or ruptures. I am following other authors in calling the fruits capsules, therefore, by interpreting the term in a broad sense. The number of seeds per capsule varied from 6 on small plants to 21 on some of the more vigorous plants. In the smaller capsules the fewer seeds were erect and terminated at about the same level, whereas in the larger capsules some seeds were erect while others were divergent and not terminating at the same level. All seeds were borne from or near the base of the capsule. The funiculi, however, sometimes varied in length. This caused distinct variation in seed position from capsule to capsule. See Figures 2 and 3 for opposing views of seven seeds attached to a placenta from a single locule. From our detailed study of individual seeds under a dissecting microscope at 40× and a compound microscope at 100× we determined that the seeds were nearly straight to slightly curved, 475-742μ long and 225-310μ wide, and the pits were angled and in 8-11 rows of 10-14 each. See Figure 4 for drawing of a typical seed.

This combination of characters is not found in the description given for any taxon recorded for eastern North America as may be seen from the following discussion. A comparison

of our data with descriptions given in literature indicates that the Georgia material can be neither *E. minima* (especially since this taxon has seeds with rounded pits) nor *E. americana* which according to Fassett (1939) has seeds in 6-8 rows of 16-25 pits each. Gleason (1952) also describes *E. americana* as having 16-25 pits while Fernald (1950) states that there are 20-30 in each row.

Can the Georgia material, therefore, be either *E. triandra* Schkuhr or *E. brachysperma* Gray which also are reported for the eastern United States? If we follow Fernald (1950) or Gleason (1952), both taxa are eliminated for these authors indicate that the seeds are borne along an axile placenta. Muenscher (1944) lists only *E. triandra* but agrees with the other authors in regard to placentation. If Fassett's (1957) key is followed, the Georgia material is *E. triandra* var. *brachysperma*. His illustration of the seed of this taxon, however, strongly indicates that the number of rows of pits can be scarcely more than six and is probably five. In Fassett's (1939) description for this taxon the pits are reported as being 6-8 rows. The Georgia material has 8 to 11 rows. Furthermore, maximum seed length exceeds his earlier (1939) value by 142μ. The Georgia material of *Elatine*, therefore, does not match the characters presented for any taxon recorded for eastern North America. Three interpretations of this situation seem possible. The material could be a new taxon, or a taxon new to the United States, or there may have been misinterpretation of the taxa in the United States. I believe the latter is true.

A major problem in properly delimiting the taxa in the past seems to have involved interpretation of the manner of placentation. Fernald (1941, 1950) maintains that *E. minima* and *E. americana* have basal placentation while in *E. triandra* and *E. brachysperma* it is axile. Gleason (1952), however, maintains that only *E. minima* has basal placentation and that the other three taxa (as varieties of a single species, *E. triandra*) ". . . have seeds borne along an elevated placenta, therefore overlapping and terminating at different levels." Placentation is not utilized by Fassett (1939, 1957). Under Fernald's interpretation of placenta-

tion the Georgia material can be only *E. americana* yet characteristics of the seeds do not match (pits 10-14 per row instead of 20-30 and diameter 225-310μ instead of 140-190μ). It seems probable that Fernald was misled about seed arrangement, with Gleason (1952) and Muenscher (1944) apparently falling into the similar error. It seems significant that Miss Farr and I were misled by some of our earlier dissections. I now believe that all species of Eastern North America have placentae near the lower part of the locule.

If placentation is considered to be uniformly at the base, then how shall the taxa represented in eastern North America be interpreted? *E. minima* seems quite distinct with rounded pits and flowers mostly two-merous, the other taxa having angular pits and three-merous flowers. Let us next examine separation of these latter taxa on the basis of seed characteristics, which appear to be the only ones of diagnostic value. Seed characteristics obtained from literature for these taxa and for a South American taxon (*E. triandra* var.

Table 1. Seed characteristics for the *Elatine* taxa and population indicated. Some data were taken directly from the authors cited while other data were determined from drawings made to scale. The names are not designated as to whether or not they are species or varieties for some have been treated as both.

CATEGORY		No. rows of pits	No. pits per row	Length μ	Width μ
triandra	Fassett, 1957	6	—	580	170
	Fernald, 1950	—	16-25	—	—
	Gleason, 1952	—	16-25	—	—
americana	Fassett, 1939[1]	6-8	16-25	400-720	140-250
	Fernald, 1950	—	20-30	—	140-190
	Muenscher, 1944	—	—	540	—
	Gleason, 1952	—	16-25	—	—
brachysperma	Fassett, 1939	6-8	9-16	350-600	160-300
	Fassett, 1957	—	—	420	—
	Gleason, 1952	—	9-15	—	—
	Fernald, 1950	—	9-15	—	—
andina	Fassett, 1939	8-10	12-19	460-680	160-280
Georgia material		8-11	10-14	475-742	225-310

[1]Fassett gives same data for *genuina* of Europe.

andina Fassett), and that determined for the Georgia material are summarized in Table 1. On the basis of these data *triandra* and *americana* appear to be the same, and may be separable from the Georgia material and *andina* which two also appear identical. A third taxon, *brachysperma,* may be distinguishable. Should, therefore, three taxa be recognized? The following seem pertinent to this question. First, there is overlap of values given for each characteristic. Secondly, a continuous morphological series of populations (most of which are probably relatively constant at each locality) seems likely to occur in nature. This is supported by Fassett (1939) who said that seed characteristics vary from locality to locality but are remarkably constant at each locality. Such "pure lines" are to be expected as a result of the self-pollination which apparently occurs abundantly under the predominately cleistogamous situation. Until evidence to the contrary is available I believe that the best way to treat this series of anastomosing populations of often different yet locally relatively constant characteristics is as one taxon, a species with no varieties. Under this interpretation *Elatine* in Eastern North America would consist of this species and *E. minima*. This most nearly agrees with Fassett's (1957) general interpretations except for some varieties which he maintains. The alternative to this thesis would be to accept three obviously closely related taxa (other than *E. minima*) for Eastern North America, one taxon being *andina* whose distribution would be Georgia, U. S. A. and Chile, South America.

Under my interpretation, all known *Elatine* of Eastern North America are either *E. minima*, with rounded pits on the seeds, or *E. triandra*, with angular pits on the seeds. A partial synonomy related to Eastern North America for the latter species follows:

Elatine triandra Schkuhr, Bot. Handb. 1, 345, t. 109b, fig. 2. 1791.
Elatine americana (Pursh) Arnott, Edinb. Journ. Nat. & Geogr. Sci. 1: 431. 1830.
Elatine brachysperma Gray, Proc. Am. Acad. 13: 361. 1878.
Elatine rubella Rydberg, Mem. N. Y. Bot. Gard. 1: 260. 1900.
Elatine triandra var. *americana* (Pursh) Fassett, Rhodora 33: 73. 1931.

Elatine triandra var. *brachysperma* (Gray) Fassett, Rhodora 41: 374. 1939.

It seems likely that material from other areas (e.g. *E. triandra* var. *andina* from Chile, *E. triandra* var. *genuina* from Europe) also belong in this species without varietal status.

The distribution by states for *Elatine triandra* in the eastern part of the United States as determined from literature and herbarium records is as follows: Missouri, Illinois, Ohio, Maine, New York, Connecticut, Pennsylvania, Delaware, Virginia, Tennessee, North Carolina, and Georgia.

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Literature Cited

Fassett, Norman C. 1939. Notes from the herbarium of the University of Wisconsin — XVII. *Elatine* and other aquatics. Rhodora **41:** 367-377.

———. 1957. A manual of Aquatic Plants, Revised Ed., University of Wisconsin Press, Madison. 405 pp.

Fernald, Merritt L. 1941. *Elatine americana* and *E. triandra*, Rhodora **43:** 208-211.

———. 1950. Gray's Manual of Botany. 8th Ed. Amer. Book Co. N. Y. 1632 pp.

Gleason, Henry A. 1952. The new Britton and Brown Illustrated Flora of the northeastern United States and adjacent Canada. Vol. 2. New York Bot. Garden. N. Y. 546-547.

Muenscher, Walter C. 1944. Aquatic plants of the United States. Comstock Pub. Co., Inc. Ithaca, N. Y. 374 pp.

Radford, Albert E. 1951. Additions to the Flora of North Carolina. Rhodora **53:** 23-27.

Small, John K. 1933. Manual of Southeastern Flora. Univ. of North Carolina Press, Chapel Hill. Reprint. 1554 pp.

DIPLOTAXIS TENUIFOLIA IN ILLINOIS AND OTHER RECORDS. This paper newly records *Diplotaxis tenuifolia* (L.) DC. for Illinois and also adds information on several infrequently collected species in the Illinois portion of the Chicago region, including parts of Cook, DuPage, Lake, and Will counties. All of the specimens cited below, except *Rhynchospora*, are in the herbarium of the University of Illinois, Navy Pier, Chicago (CHI). I wish to thank Dr. S. F. Glassman, curator of that herbarium, for the opportunity of studying the specimens.

Rhynchospora globularis (Chapm.) Small. This rare sedge is also known from Kankakee County (Jones, 1963). COOK: Sandy swamp at Thornton, *Fuller 2294* (ISM, ILLS).

Polygonum cespitosum Blume var. *longisetum* (DeBruyn) Stewart. The first report of a Cook County collection is rather recent (Steyermark *et al.*, 1957). This adventive from eastern Asia is known from only three other counties (Winterringer and Evers, 1960). Comparison with a Japanese specimen, HONSHU ISLAND: Toyama Prefecture, Yatsuo Village, *Kirino 370* (as *Polygonum longisetum* DeBruyn) has verified the identity of the following collection, which is from an abandoned lawn. COOK: Chicago, 54th, two blocks east of Hyde Park Boulevard, June 24, 1956, *Glassman 3635*.

Diplotaxis muralis (L.) DC. With this record, this European adventive species is known from all Illinois counties of the Chicago region. DU PAGE: Wheaton, along railroad, west of President Street, in loam, June 19, 1957, *Glassman 4064*.

Diplotaxis tenuifolia (L.) DC. This is the first report of this adventive crucifer in Illinois. Apparently Warren County, Indiana (Deam, 1940) is the nearest locality to Illinois in which this species has been previously collected. COOK: Burnham, Brainard Avenue & Avenue "O"; along railroad track in ballast, July 2, 1957, *Glassman 4196*. COOK: Hegewisch, Brainard, north of Burnham Road; on railroad ballast; flowers yellow; July 2, 1957, *Chapp 124*.

Silene armeria L. The Sweet William Catchfly is recorded from five counties by Winterringer and Evers (1960). In

Cook County it is reported to have been cultivated in 1866 (Jones and Fuller, 1955) and noted at two other localities (Pepoon, 1927). This species escapes to waste places, as exemplified by "Quarries at Lemont", listed by Pepoon. COOK: Chicago, 103rd and Doty, garbage dump, growing at base of large slag dump, June 26, 1954, *Eiseman 63*.

Echium vulgare L. The Blueweed is reported from Champaign and Lake counties by Jones and Fuller (1955) and additionally from LaSalle and Schuyler counties by Winterringer and Evers (1960). This species is listed for Cook County by Pepoon (1927) and Pearsall. Known previously from only two counties of the Chicago area, the following record adds another. DU PAGE: Wheaton, along railroad, west of President Street, June 19, 1957, *Glassman 4059*.

Arctium lappa L. Winterringer (1957) cites the five counties from which the Great Burdock is known in Illinois, including Cook and DuPage. To these now may be added LAKE: Chain of Lakes State Park, along border of Grass Lake, August 6, 1961, *Glassman 5626*.

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LITERATURE CITED

DEAM, C. C. 1940. Flora of Indiana, 1236 pp. Indianapolis.

JONES, G. N. 1963. Flora of Illinois. Amer. Midl. Nat. Monogr. 7:1-401. University of Notre Dame Press, Notre Dame.

JONES, G. N. and G. D. FULLER. 1955. Vascular Plants of Illinois. 593 pp. University of Illinois Press, Urbana.

PEARSALL, G. S. (undated) List of the Fauna and Flora of the Forest Preserve District of Cook County. Forest Preserve District of Cook County, Chicago.

PEPOON, H. S. 1927. An Annotated Flora of the Chicago Area. Bull. Chicago Acad. Sci. 8: 1-554.

STEYERMARK, J. A., F. A. SWINK, and J. W. THIERET. 1957. Plants New to Illinois and Indiana and the Chicago Region. Rhodora 59: 31-33.

WINTERRINGER, G. S. 1957. Arctium in Illinois. Rhodora 59: 44.

WINTERRINGER, G. S. and R. A. EVERS. 1960. New Records for Illinois Vascular Plants. 135 pp. Ill. State Mus. Scientific Papers Series, Vol. XI.

POLLEN DIMORPHISM IN HETEROSTYLED OLDENLANDIA UMBELLATA

BIR BAHADUR

In a previous paper the author (Bir Bahadur, 1963) dealt with dimorphic heterostylism in *Oldenlandia umbellata* L., a member of the Rubiaceae of the tribe Oldenlandeae and also reviewed the heterostyled Rubiaceae so far known. In the present paper the exine dimorphism of *O. umbellata* L., is described.

In heterostyled plants pollen dimorphism is invariably associated with style and stigma dimorphism. Usually small pollen grains are found in the low anthers of long styled forms, called Pins, and large pollen grains in the high anthers of small styled forms, called Thrums. Almost all heterostyled species, with exception of *Linum grandiflorum*, (Lewis, 1941), exhibit this phenomenon. (Baker, 1954, 1956, 1958, 1961; Bir Bahadur, 1963).

Among the features which distinguish the heterostylic incompatibility system, the exine dimorphism of pollen grains is one (Lewis, 1956, Baker, 1954). The earlier literature has been reviewed several times by Baker. He found that the tribe Staticeae of the Plumbaginaceae contains self-incompatible heterostyled species, where two kinds of pollen, type A and type B, are associated with the Cob and Papillate stigmas respectively. Type A has a complex ornamentation with polygonal lumina, while type B has less fine ornamentation. A similar phenomenon also occurs in the Rubiaceous species *Rudgea jasminoides*, (Baker, 1956), where in short styled flowers the pollen grain has a spiny exine and in long styled flowers the pollen grain has a smooth exine. A similar case is also reported in a heterostyled species of *Linum* by Laibach (quoted by Saad, 1961).

More recently Wendelbo (1961 a and b) in his extensive studies of the Primulaceae has noted pollen dimorphism for *Hottonia palustris* and *Dionysia* species.

In the genus *Oldenlandia* pollen dimorphism has been known since the days of Darwin, (1892). Recently, Breme-

kamp (1952), Baker (1958) and the present author have shown correlated pollen dimorphism in the heterostyled species, but except for *O. angustifolia* none of the species of this genus has been studied palynologically (Erdtman, 1952). Very recently Verdcourt (1958) and Hallé (1961) studied pollen grains of the Rubiaceae and Mussaendeae respectively in detail, but, however, have not reported exine dimorphism in any heterostyled species.

For the study of exine morphology of pollen grains of Pin and Thrum forms of *O. umbellata,* polliniferous material was acetolysed separately according to the procedure described by Erdtman (op. cit.). Separate slides of Pin and Thrum pollen grains were examined by taking photomicrographs at different foci in a sequence. Thirty to forty pollen grains were measured for polar and equatorial diameters.

Pollen grains from Thrum flowers: —

Pollen grains larger tricolporate, longicolpate, subprolate, (24.35 × 20.5μ). Ora slightly lalongate, colpae 18.8μ long, gradually tapering on either side of the pollen grain, membrane smooth. Sexine as thick as nexine, reticulate, homobrochate, lumina usually hexagonal, psilate (1-2μ), muri simplibaculate, meshes gradually increasing in size from centre towards periphery. (Figs. 1-3)

Pollen grains from Pin flowers: —

Pollen grains small, tricolporate, longicolpate, subprolate, (21.5 × 18.3μ). Ora slightly lalongate, often circular, colpae 14.66μ long, gradually tapering on either pole, membrane smooth, exine crassisexinous, reticulate, homobrochate, lumina hexa to polygonal, finer than that of thrum, psilate, muri simplibaculate, meshes gradually increasing in size from centre towards periphery. (Figs. 4-6)

From the above description it is evident that pollen dimorphism similar to *Rudgea jasminoides* is also found in *Oldenlandia umbellata* L.; however, the differences as in *Rudgea* are not very marked.

Thus pollen dimorphism associated with exine dimorphism which in turn is associated with heterostyly and heterostameny occurs in *O. umbellata* L. (c.f. Bir Bahadur, l.c.)

As this phenomenon has been considered to be of impor-

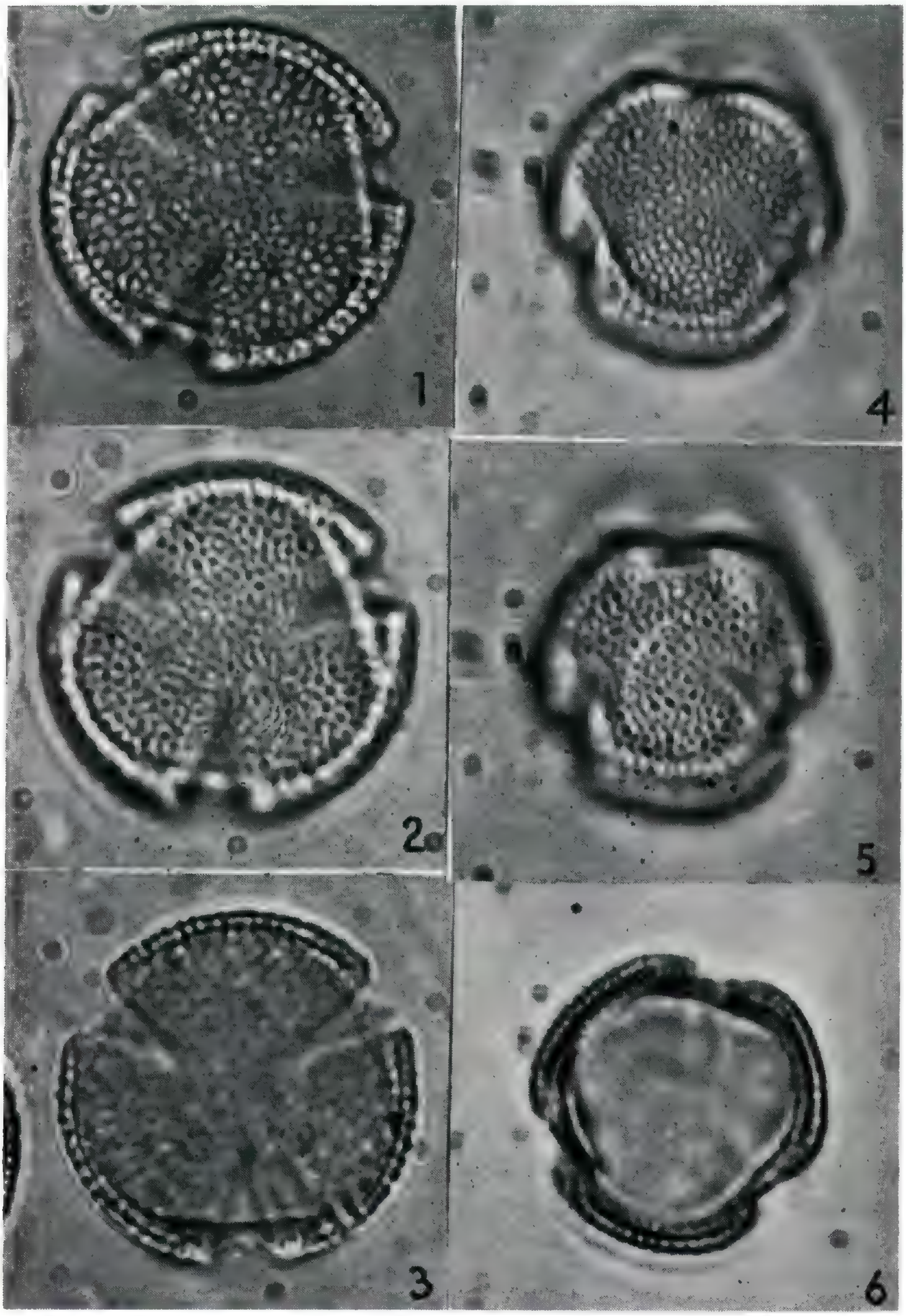

Plate 1294

Figs. 1-3 Thrum pollen of *Oldenlandia umbellata* L., in three different foci × 1250 approx.

Figs. 4-6 Pin pollen of *O. umbellata* L., × 1250 approx.

tance in revealing the phylogenetic and phytogeographical limitations of polymorphic species and also in tracing the history and evolution of tropical floras, (c.f. Baker, 1954, 1956), it is suggested that the heterostyled Rubiaceae as well as other heterostyled species in general should be investigated for pollen dimorphism.

The author expresses his appreciation to Dr. M. Hashim, Reader, Genetics Laboratory, Osmania University, for guidance and criticism during the course of this investigation. Grateful acknowledgement is also made to Prof. M. R. Saxena, Head, Dept. of Botany, Osmania University, for facilities and encouragement. The financial assistance of the Ministry of Education, Government of India for the award of a Research Training Scholarship is also acknowledged.

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References

Baker, H. G. (1954) Dimorphism and incompatibility in the Plumbaginaceae. Rapp. et. comm. 8. eme Congr. Int. de Bot. Paris, **10**, 133-134.

——— (1956) Pollen Dimorphism in the Rubiaceae. Evolution, **10**, 23-31.

——— 1958) Studies in the reproductive biology of West African Rubiaceae. J. W. African Sci. Assoc. **4**, 9-24.

——— (1961) Heterostyly and Homostyly in *Lithospermum canescens*, (Boraginaceae). Rhodora, **63** (752), 229-235.

Bir Bahadur. (1963) Heterostylism in *Oldenlandia umbellata* L. Jour. Genet. 58:429-439.

Bremekamp, C. E. B. (1952) The African species of *Oldenlandia* L, sensu Hiern et Schumann. Amsterdam.

Darwin, Ch. (1892) The different forms of flowers on plants of the same species. London.

Erdtman, G. (1952) Pollen Morphology and plant taxonomy. 1. Angiosperms. Chronica Botanica, U. S. A.

Hallé, F. (1961) Contributions to a taxonomical and biological study of Mussaendeae. Adansonia, **1**, 266-298.

Lewis, D. (1941) The physiology of incompatibility in plants. 11. *Linum grandiflorum*. Ann. Bot. N.S. **7**, 115-122.

——— (1956) Incompatibility and Plant Breeding. Genetics in Plant Breeding. Brookhaven Symp. Biol. **9**, 89-100.

SAAD, S. I. (1961) Pollen morphology and sporoderm stratification in *Linum*. Grana Palyn, **3**, 109-129.

VERDCOURT, B. (1958) Remarks on the classification of the Rubiaceae. Bull. Jard. Bot. Etat. Brux., **28**, 209-281.

WENDELBO, PER (1961) Studies in Primulaceae. 1. A monograph of the genus *Dionysia*. Univ. Bergen. Arbok. Mat. Naturv, **3**, 1-83.

——————— (1961b) Studies in Primulaceae. 11. An account of *Primula* sub genus *Sphonodylia* with a review of the sub division of the genus. Ibid., **11**, 1-31.

ADDITIONS TO THE WOLF ISLANDS FLORA, 1963

A. R. Hodgdon and R. B. Pike

It was emphasized in our paper on the Machias Seal Islands (Rhodora **64:** 344, 1962) that even on small islands new taxa may be discovered after botanizing seems to have been thoroughly done. We now have seven species from our 1963 collections to add to our list of vascular plants of the Wolf Islands, New Brunswick, (Rhodora **65:** 82-96, 1963) and this despite the fact that we made only two visits there in 1963 and searching for new species was not the main objective at either time. An eighth species to add to the flora of the islands is *Pyrus americana* (Marsh.) DC. We have made nearly thirty collections of Mountain-ash from the Wolf Islands, many at the time of flowering in late June 1963. Dr. Shiu-Ying Hu of the Arnold Arboretum staff has kindly identified twenty-six of our collections for us. Eighteen of these proved to be *Sorbus decora* (Sargent) Schneider (*Pyrus decora* (Sargent) Hyland) and the remaining eight *Sorbus americana* Marshall (*Pyrus americana* (Marsh.) DC.). We now can report *P. americana* from East Wolf and Fat Pot Islands. The generally more common *P. decora* is probably present on all the islands except Gull Rock which has no woody vegetation at all.

RECENTLY DISCOVERED SPECIES ON THE WOLF ISLANDS

Salix pyrifolia Anderss. (East Wolf)
Geocaulon lividum (Richards.) Fern. (E. Wolf)
Spiraea tomentosa L. (E. Wolf)
Viola lanceolata L. (South Wolf)
Vaccinium myrtilloides Michx.
Hieracium pilosella L. (S. Wolf)
H. florentinum All. (S. Wolf)

While we intend to discuss the significant taxa on the Wolves in some detail in a special treatment, it may be desirable to point out that several of these new species were fully expected, species of *Hieracium*, for example. The *Viola lanceolata* was found only in the vicinity of the lighthouse on South Wolf, now dismantled, and may well have been introduced from the mainland. We might have expected to see

Spiraea tomentosa in earlier years. But the occurrence on East Wolf Island of *Salix pyrifolia* and *Geocaulon lividum* add support to our present feeling that the flora of the Wolves is characterized by a pronounced boreal influence.

Also, we are appending herewith a list of added taxa on Gull Rock, Wolf Islands, which as noted earlier (p. 96) we had not been able to finish because of adverse weather conditions in 1962. These now make Gull Rock as well surveyed as the other islands.

ADDITIONS TO THE VASCULAR FLORA OF GULL ROCK

Festuca rubra L. var *commutata* Gaudin
Puccinellia laurentiana Fern. & Weath. var. *laurentiana*
Puccinellia paupercula (Holm) Fern. & Weath. var. *alaskana* (Scribn. & Merr.) Fern. & Weath.
Agropyron repens (L.) Beauv. f. *trichorrhachis* Rohlena
Lathyrus japonicus Willd. var. *pellitus* Fern.
Aster novi-belgii L.

This brings the total taxa on Gull Rock to 35.

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FASCIATION IN EMPETRUM NIGRUM — Fasciation is a commonly observed yet still little understood abnormal growth pattern. It is worth recording its occurrence in a previously unreported species as a matter of record. *Empetrum nigrum* with fasciated growth in typical cockscomb form was collected on Great Wass Island, Beals, Washington County, Maine September 1963 and has been deposited in the Herbarium of the University of New Hampshire.

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CHROMOSOME NUMBERS IN RACES OF HAPLOPAPPUS DIVARICATUS[1]

EDWIN B. SMITH

Haplopappus divaricatus (Nutt.) Gray is a wide-ranging annual with a distribution in north-central Kansas, southward through Oklahoma and Texas, eastward through the Gulf Coast states, and northward on the Atlantic seaboard to South Carolina. It is sometimes treated as a distinct genus, *Croptilon*, but Hall (1928) placed it in the section *Isopappus* of *Haplopappus* with another species, *H. occidentalis*. However, Keck (1956) has raised *H. occidentalis* to generic status as *Benitoa occidentalis* and *H. divaricatus* remains the only species of the section.

Chromosome counts of $n = 4$ (Turner, 1960) and $n = 5$ (Jackson, 1959) have been reported for *H. divaricatus*. To determine the significance of the distribution of these numbers, field studies were made through Kansas, Oklahoma, Texas, and parts of Arkansas. In addition, seed was obtained from Georgia and Florida. Live transplants were collected for hybridizations, buds were fixed for cytological study, and herbarium specimens were made for later measurement.

From these studies, five morphologically distinct "races" have been found which form an aneuploid series of $n = 4$, $n = 5$, $n = 6$, and $n = 7$. Table 1 gives brief morphological descriptions of the races, their chromosome numbers, and collection sites. A more complete delimitation of their morphological variation must await detailed population studies. Figures 1-6 are meiotic metaphase I configurations of four of the races.

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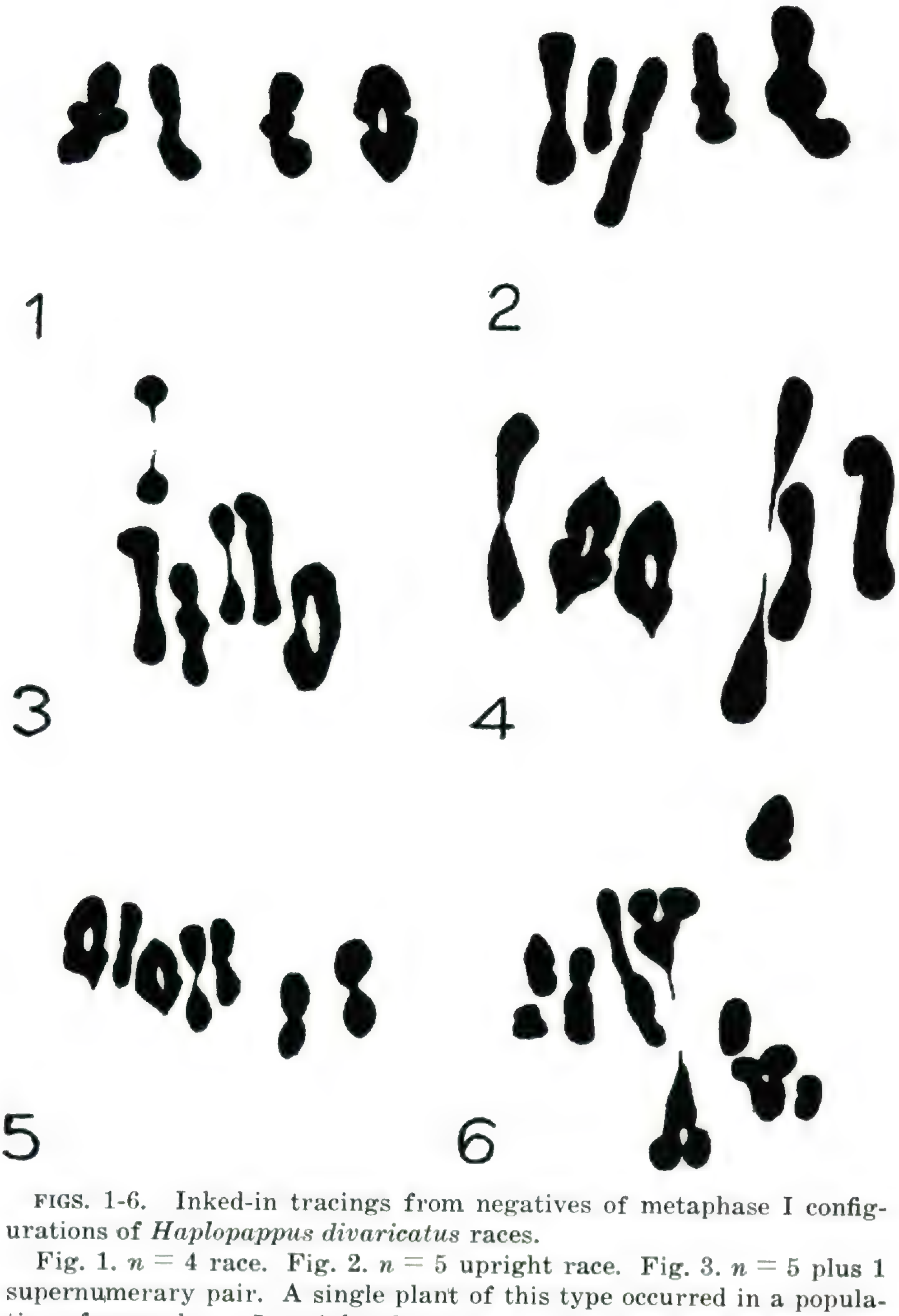
[1]This study was supported in part by a National Science Foundation Summer Fellowship.



FIGS. 1-6. Inked-in tracings from negatives of metaphase I configurations of *Haplopappus divaricatus* races.

Fig. 1. $n = 4$ race. Fig. 2. $n = 5$ upright race. Fig. 3. $n = 5$ plus 1 supernumerary pair. A single plant of this type occurred in a population of normal $n = 5$ upright plants sampled in Rice Co., Kansas. Fig. 4. $n = 6$ race. Fig. 5. $n = 7$ race. Fig. 6. A morphologically $n = 7$ plant with anomalous pairing, probably a hybrid, with a total of 19-20 chromosomes. A single plant of this type occurred in a population of normal $n = 7$ plants sampled in Gillespie Co., Texas.

TABLE 1. Descriptions, chromosome numbers, and collection sites of the races of *Haplopappus divaricatus*.

Description	n	Collection Sites
Upright, broad-leaved, small heads	4	OKL., MCCURTAIN Co., 0.4 mi. n. of Tom. ARK., LITTLE Co., 5 mi. n.w. of Winthrop. GA., TIFT Co., near Tifton. FLA., LEON Co., 4 mi. s.e. of Tallahassee.
Upright, broad-leaved, medium-sized heads	5	KANS., DICKENSON Co., 2.9 mi. w. of Abilene. SUMNER Co., 2 mi. w. of Argonia. HARPER Co., 1.2 mi. e. of Harper.
Decumbent, medium-width leaves, small heads	5	TEX., GONZALES Co., 10 mi. n.w. of Gonzales. ARANSAS Co., Goose Island State Park. BROOKS Co., 8 mi. s. of Falfurrias. LIVE OAK Co., 3.9 mi. n. of Three Rivers.
Upright, medium-width leaves, medium-sized heads.	6	TEX., GUADALUPE Co., 7 mi. s. of Seguin. GOLIAD Co., 3.6 mi. n.w. of Charco. GONZALES Co., 1.2 mi. n. of Gonzales.
Upright, narrow-leaved, large heads	7	TEX., BURNET Co., Inks Lake Park. GILLESPIE Co., 4 mi. n. of Fredricksburg. MASON Co., 2 mi. s. of Air.

Intraracial perenniality was observed in several collections of the $n = 5$ decumbent race. Studies of somatic chromosomes show this to have the most symmetrical genome of the five races. Since perenniality in growth and symmetry of genome are both considered primitive characteristics (Stebbins, 1950), this race may be the progenitor of the other races. If this is true, then aneuploidy in the species would be ascending and descending. Documented evidence for ascending aneuploidy in the Compositae is lacking (Jackson, 1962).

Study of meiotic pairing in F_1 intraracial hybrids, presently being grown, should disclose whether aneuploidy in the species is ascending, descending, or a combination of the two.

In addition, presence or absence of hybrid sterility barriers will be useful in delimiting by formal taxonomic rank the entities referred to here as races.

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Literature Cited

Hall, H. M. 1928. The genus *Haplopappus*. A phylogenetic study in the Compositae. Carnegie Inst. Wash. Publ. 389.

Jackson, R. C. 1959. Documented Chromosome Numbers. Madroño 15:52.

———. 1962. Interspecific hybridization in *Haplopappus* and its bearing on chromosome evolution in the Blepharodon section. Am. Jour. Bot. 49:119-132.

Keck, D. D. 1956. *Benitoa*, a new Genus of Compositae from California. Leaf. West. Bot. 8:25-40.

Stebbins, G. L. 1950. Variation and Evolution in Plants. Columbia U. Press. N. Y.

Turner, B. L. and W. L. Ellison. 1960. Chromosome numbers in the Compositae 1. Meiotic chromosome counts for 25 species of Texas Compositae including 6 new generic reports. The Texas Jour. Sci. 7(3,4) : 147.

A SYSTEMATIC STUDY OF THE GENUS BAHIA (COMPOSITAE)[1]

WILLIAM L. ELLISON

Bahia, a genus in the tribe Helenieae, is restricted to North and South America, a single species only occurring on the latter continent. Increased attention has been given to the Helenieae within recent years by American workers,[2] due at least in part to geographic considerations and the fact that ample material, including many types, is available in herbaria in the United States.

Small (1919, p. 312) and Cronquist (1955), among others, have questioned the naturalness of the tribe Helenieae. Whereas no attempt is made in the present study to evaluate the taxonomic status of the tribe, the study of *Bahia* should eventually prove helpful in answering questions on this level.

The major phase of the study has been an assessment of the taxa which fall within the generic limits of *Bahia.* The judgments have been based upon field work in the area of major concentration of the genus, examination of some 2000 herbarium specimens, and garden and greenhouse cultures, as well as upon data derived from chromosome counts, biochemical (chromatographic) study and fertility tests. After consideration of the above data, the writer has recognized 15 taxa as belonging to the genus *Bahia:* 13 species (including one new one) and 2 varieties. It is believed that the present treatment clarifies the relationships of *Bahia* with

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[1]Part of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Texas. The study was supported, in part, by National Science Foundation Grants 9025 and 15890.

[2]The following taxa have been monographed, revised or partially treated since 1950: *Baeria* (Ornduff, unpubl.); *Eriophyllum* and related genera (Carlquist, 1956); *Florestina* (Turner, 1963); *Gaillardia* (Stoutamire, 1958); *Helenium* (Rock, 1957); *Hymenopappus* (Turner, 1956); *Hymenothrix* (Turner, 1962); *Hymenoxys* (Parker, unpubl.); *Lasthenia* (Ornduff, unpubl.); *Palafoxia* (Turner, unpubl.); *Perityle* (Shinners, 1959).

other comparable groups in the subtribe Bahianae and places the species in natural genera which, it is hoped, are monophyletic.

TAXONOMIC HISTORY

The genus *Bahia* was named by Mariano Lagasca in 1816 in honor of Juan Francisco Bahi, professor of botany at Barcelona, Spain. It was typified by *B. ambrosioides*, a species described from a specimen presumably collected in the vicinity of Concepción, Chile, South America, by an individual now unknown. Nuttall (1818) described the first species of the genus recognized in North America, *B. oppositifolia*, as one member of his newly proposed *Trichophyllum*. De Candolle (1836), however, included *Trichophyllum*, together with the genera *Eriophyllum* Lag. and *Phialis* Spreng., in the genus *Bahia*. In a later paper Nuttall (1841), contrary to the present Code of Botanical Nomenclature, adopted the name *Bahia* for the North American elements of the genus and proposed the name *Stylesia* for the South American ones. This nomenclatural arrangement persisted until 1874.

Gray (1874) interpreted the genus *Schkuhria* Roth. to embrace three sections, two of which included only annuals. He transferred some of the annual species of *Bahia* ("*Eriophyllum* section") to *Actinolepis* DC. and the remainder to one of the annual sections of *Schkuhria* while retaining the perennial species (including those of the "*Eriophyllum* section") in the genus *Bahia*. Subsequently, Gray (1884) undertook a critical appraisal of the generic distinctions between *Bahia*, *Eriophyllum*, *Schkuhria* and related genera. This was the first attempt to give some order to the total complex and to indicate the natural relationships among the included species. *Bahia*, which he differentiated from both *Eriophyllum* and *Schkuhria* by a combination of morphological characters, was newly interpreted to comprise three sections: (1) five suffruticose or perennial taxa, (2) two herbaceous species with perennial caudices, and (3) nine annual taxa. A yet more critical treatment of *Bahia* by Gray (1886) left unchanged his division of the genus into three sections. He

recognized 11 species and one variety in this final expression of his concept of the genus.

A number of new species were described in the interim between Gray and Rydberg. In Rydberg's (1914) treatment of *Bahia* however, only 11 species (including 2 newly described species) and no varieties were included because of his proposed generic segregates (e.g., *Achyropappus, Amauriopsis, Picradeniopsis*).

The present treatment holds to the essential unity of the genus as expressed by Gray while recognizing the validity of two of Rydberg's several generic segregates.

CHROMOSOMAL STUDIES

Chromosome counts of $n = 8$, 11, 12 and 24 have been reported for the genus *Bahia* (Turner, 1959; Turner and Johnston, 1961; Turner, Beaman and Rock, 1961). As a result of the present study, an even more interesting array has become evident: $n = 8$, 11, 12, 18, 22, and 24, plus a single count of $n = 10$ in a species *(B. schaffneri)* previously known to have only the haploid number of 8.[3] A discussion of the taxonomic significance and phylogenetic interpretation of the chromosomal information is deferred until later in this chapter.

Methods. Collections of buds for chromosomal studies were made in the field during the summers of 1959 and 1960.[4] Chromosome counts were likewise made from collections which were grown in the garden for chromatographic and fertility studies. In all instances, the buds were fixed in a modified Carnoy's solution (4 parts chloroform: 3 parts absolute alcohol: 1 part glacial acetic acid) and placed under refrigeration as soon as possible. Buds remained in this solution for a period varying from several hours to several weeks. Entire florets were subsequently squashed in an aceto-orcein lactic acid stain (0.5% orcein in a solution of 1 part glacial acetic acid: 1 part lactic acid: 1 part water).

[3]Since the completion of this study by the writer, a count of $n = 36$ for *B. absinthifolia* var. *dealbata* has been made by A. M. Powell *(Turner 4749)*.

[4]Voucher specimens are deposited in the University of Texas Herbarium.

Camera lucida drawings were made at magnifications of ca. × 1,500.

Results. *B. absinthifolia* var. *absinthifolia* has been reported to have a chromosome number of $n = 12$ (Turner and Johnston, 1961; Turner, Beaman and Rock, 1961). Information derived from this study indicates that a number of $n = 24$ is more common, the diploid populations being found only in the Mexican states of Nuevo León and San Luis Potosí. No morphological distinctions between the diploids and tetraploids were apparent in the field or in subsequent study of the vouchers. Similarly, a previous account (Turner and Johnston, 1961), has reported $n = 24$ for *B. absinthifolia* var. *dealbata*. Whereas the tetraploid number is the more prevalent, diploid populations were found in this variety as well. A single count of $n = 36$ is reported from Arizona *(Turner 4749)*. I have made an approximate count of $n = 26$ from a single Texas population *(E. & T. 14)*[5] and Turner (unpublished) has found a similar count from a Mexican population *(Rock 483)*. Additional data are needed in order to discuss adequately the geographic distribution of both varieties of *B. absinthifolia* with regard to their chromosomal numbers. Karyotypic studies and further genetic tests should prove to be most informative.

Confirmation was made of $n = 12$ for *B. pedata* and $n = 8$ for *B. schaffneri*, the original counts having been reported by Turner and Johnston (1961). The additional chromosome

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Fig. 1-8. Camera lucida drawings of meiotic chromosomes of taxa of *Bahia*. All ca. × 900. Fig. 1. *B. absinthifolia* var. *absinthifolia*, $n = 12$, metaphase I *(Johnston 4214B)*. Fig. 2. *B. a.* var. *absinthifolia*, $n = 24$, diakinesis *(E. & G. 114)*[6]. Fig. 3. *B. a.* var. *dealbata*, $n = 12$, diakinesis *(E. & T. 24)*. Fig. 4. *B. a.* var. *dealbata*, $n = 24$, metaphase II *(E. & T. 13)*. Fig. 5. *B. a.* var. *dealbata*, $n = 36$, metaphase I *(Turner 4749)*. Fig. 6. *B. bigelovii*, $n = 11$, diakinesis, *(E. & T. 19)*. Fig. 7. *B. pringlei*, $n = 22$, metaphase I, *(E. & G. 83)*. Fig. 8. *B. xylopoda*, $n = 11$, metaphase II, *(Johnston 4051A)*.

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[5]The initials *E. & T.* are used throughout this study to designate collections by *W. L. Ellison* and *B. L. Turner*.

[6]The initials *E. & G.* are used to designate collections by W. L. Ellison and A. Garcia, *E. & T.* to designate collections by W. L. Ellison and B. L. Turner.

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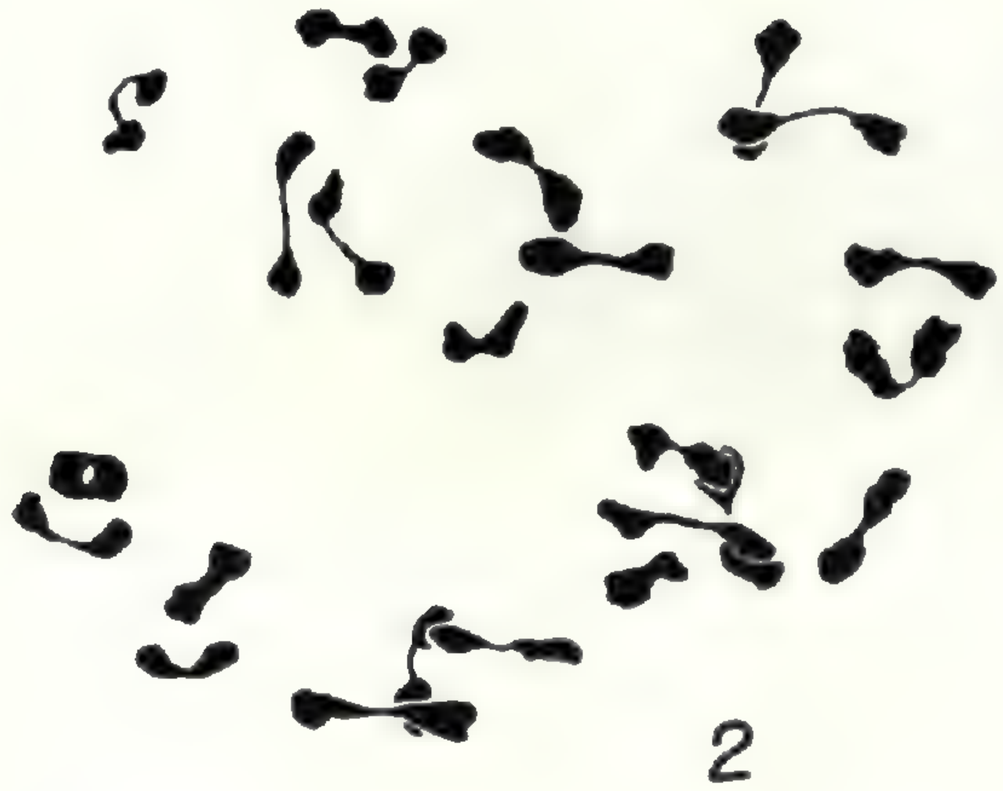

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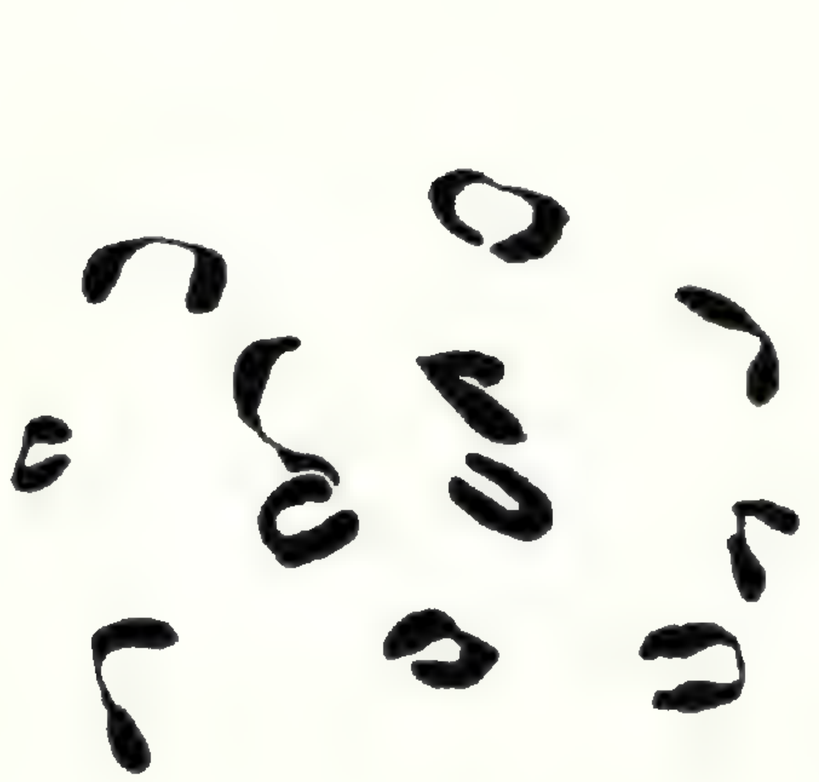

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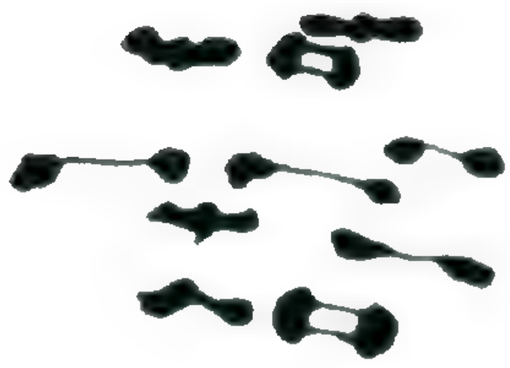

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number of $n = 10$ for *B. schaffneri* presents an interesting problem for future study. *B. xylopoda* was confirmed to have a chromosome number of $n = 11$, as originally reported by Turner, Beaman and Rock (1961). Turner and Johnston (1961) indicate a haploid number of $n = 11$ for *B. pringlei;* a study of the voucher sheets indicates that these are to be attributed to *B. xylopoda.*

In all the collections from which meiotic counts were made, pairing was regular with the exception of a ring of 4 in most plants examined from a single population of *B. pringlei (E. & G. 78).* Chromosome fragmentation was occasionally encountered in *B. absinthifolia* var. *dealbata.*

In addition to determinations of chromosome numbers for species of *Bahia,* counts were made of taxa in the related genera *Schkuhria* and *Achyropappus.* The South American *S. multiflora* has been reported to have a number of $n = 11$ (count by Schnack and Covas, 1947). The present count of $n = 11$ for the North American element constitutes additional evidence to substantiate Heiser's (1945) treatment of this bicentric species.

Eight different chromosome numbers are currently known for *Bahia,* and thus the genus lends itself quite well to phylogenetic speculations based upon such information. One may hypothesize a base number of $x = 8$ for the genus. Under this supposition *B. schaffneri* would be diploid ($2x = 16$) and *B. autumnalis, B. glandulosa* and *B. pedata* triploids ($3x = 24$). *B. absinthifolia* var. *absinthifolia* and var. *dealbata* would be either triploid, hexaploid ($6x = 48$) or enneaploid ($9x = 72$). *B. dissecta* ($n = 18$) could be of hybrid

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Fig. 9-17. Camera lucida drawings of meiotic chromosomes of species of *Bahia, Schkuhria* and *Achyropappus.* All ca. × 900. Fig. 9. *B. schaffneri,* $n = 8$, diakinesis *(E. & G. 71).* Fig. 10. *B. schaffneri,* $n = 10$, anaphase I *(E. & G. 109).* Fig. 11. *B. autumnalis,* $n = 12$, diakinesis *(Johnston 4241).* Fig. 12. *B. dissecta,* $n = 18$, metaphase II *(E. & T. 22).* Fig. 13. *B. glandulosa,* $n = 12$, diakinesis *(King 3737).* Fig. 14. *B. pedata,* $n = 12$, diakinesis *(E. & T. 29).* Fig. 15. *S. multiflora,* $n = 11$, metaphase I *(Ellison 171).* Fig. 16. *S. schkuhrioides,* $n = 8$, diakinesis *(E. & G. 107).* Fig. 17. *A. anthemoides,* $n = 10$, anaphase I *(E. & G. 93).*

origin, the hypothetical parents being triploid and hexaploid. *B. bigelovii* and *B. xylopoda* would be aneuploids derived from hypothetical triploid ancesters ($3x-2 = 22$ or $n = 11$); *B. pringlei* ($n = 22$) could then be assumed to have arisen as a tetraploid from this aneuploid line. No explanation is offered to account for the chromosome number of $n = 10$ found in the single population of *B. schaffneri;* however, it should be noted that a similar but more striking example may be found in the genus *Hymenoxys* where *H. odorata* has morphologically similar populations with counts of $n = 11$ and $n = 15$ (Turner, Beaman and Rock, 1961).

According to the views of Turner, Ellison and King (1961), it is perhaps more probable that the ancestral number is $x = 4$. Thus, *B. schaffneri* would be a tetraploid ($4x = 16$), *B. autumnalis, B. glandulosa* and *B. pedata* hexaploids ($6x = 24$), and *B. absinthifolia* either hexaploid, 12-ploid ($12x = 48$), or 18-ploid ($18x = 72$). It seems probable that the 18-ploid *B. absinthifolia* was derived from hexaploid and 12-ploid parents of this species. *B. dissecta* could have been variously derived as a hybrid from hypothetical hexaploid and 12-ploid parents or as an allopolyploid from triploid and hexaploid parents. *B. bigelovii* and *B. xylopoda,* as noted in the previous paragraph, may be considered to have been derived by aneuploid loss with *B. pringlei* a result of doubling of the aneuploid number. This phylogenetic scheme of relationships is pictured diagrammatically in Fig. 18 for the 10 taxa for which counts are known.

Rather than assuming a base number of 4 or 8, one could select the number 6. Based on $x = 6$, he would have tetraploids ($4x = 24$), a single hexaploid ($6x = 36$), octoploids ($8x = 48$), and a single 12-ploid ($12x = 72$), in addition to the two numbers derived from aneuploid loss. The $2n = 16$ chromosome number could presumably be derived by aneuploid gain or loss, but no aneuploid series exists to lend credence to this hypothesis. Against the hypothetical base of 6, too, is the fact that no diploids ($2x = 12$) are currently known for *Bahia* or any of the related genera in the subtribe Bahianae. The ploidy levels do lend support to the hypotheti-

cal base of 6, however, there being no necessity for assuming the origin of spontaneously occurring, fertile triploids. Both the triploid taxa and the single hybrid species as proposed for the base number 8 present theoretical problems of fertility. This problem is likewise encountered, but only for the single species *B. dissecta*, when the base number $x = 4$ is assumed.

TABLE I. Chromosome Numbers in the Genera *Bahia, Schkuhria* and *Achyropappus.*

B. absinthifolia var. *absinthifolia.* $n = 12$: MEXICO, NUEVO LEON, *Johnston 4214B*, *E. & G. 50, 56*, SAN LUIS POTOSÍ, *E. & G. 57, 58.* $n = 24$: AGUASCALIENTES, *E. & G. 108*, DURANGO, *E. & G. 116, 127*, NUEVO LEON, *E. & G. 55*, SAN LUIS POTOSÍ, *E. & G. 64, 70* ZACATECAS, *E. & G. 112, 114.*

B. absinthifolia var. *absinthifolia* > *dealbata.* $n = 24$: MEXICO, CHIHUAHUA, *E. & G. 153.*

B. absinthifolia var. *dealbata.* $n = 12$: TEXAS, *E. & T. 28.* $n = 12+2B$: TEXAS, *E. & T. 27.* $n = 24$: TEXAS, *E. & G. 34*, *E. & T. 13, 15;* MEXICO, CHIHUAHUA, *E. & G. 138*, COAHUILA, *E. & G. 48.* $n = 36$: ARIZONA, *Turner 4749* (count by A. M. Powell).

B. bigelovii. $n = 11$: TEXAS, *E. & G. 169*, *E. & T. 19.*

B. dissecta. $n = 18$: TEXAS, *E. & T. 22.*

B. glandulosa. $n = 12$: MEXICO, DURANGO, *E. & G. 118, 125*, *A. M. Powell & J. Edmondson 939* (count by A. M. Powell).

B. pedata. $n = 12$: TEXAS, *E. & G. 168*, *E. & T. 16, 29;* MEXICO, CHIHUAHUA, *E. & G. 139.*

B. pringlei. $n = 22$: MEXICO, HIDALGO, *E. & G. 78, 83, 86, 90.*

B. schaffneri. $n = 8$: MEXICO, GUANAJUATO, *E. & G. 71*, SAN LUIS POTOSÍ, *E. & G. 65, 68*, *A. M. Powell & J. Edmondson 548* (count by A. M. Powell). $n = 10$: MEXICO, AGUASCALIENTES, *E. & G. 109.*

B. xylopoda. $n = 11$: MEXICO, HIDALGO, *E. & G. 89*, *A. M. Powell & J. Edmondson 605* (count by A. M. Powell).

Schkuhria multiflora. $n = 11$: TEXAS, *Ellison 171.*

S. schkuhrioides. $n = 8$: MEXICO, GUANAJUATO, *E. & G. 105, 107.*

Achyropappus anthemoides. $n = 10$: MEXICO, MEXICO, *E. & G. 93, 96*, *A. M. Powell & J. Edmondson 802* (count by A. M. Powell).

TESTS OF FERTILITY

Methods. Seeds collected during 1959 were germinated during January of 1960 on moist filter paper in petri dishes and were then transferred to greenhouse pots. Germination percentage was increased markedly through the use of kinetin (2-furfuryl amino purine) and gibberellin. Seeds were soaked for ten minutes in a solution of 3γ kinetin + 100γ

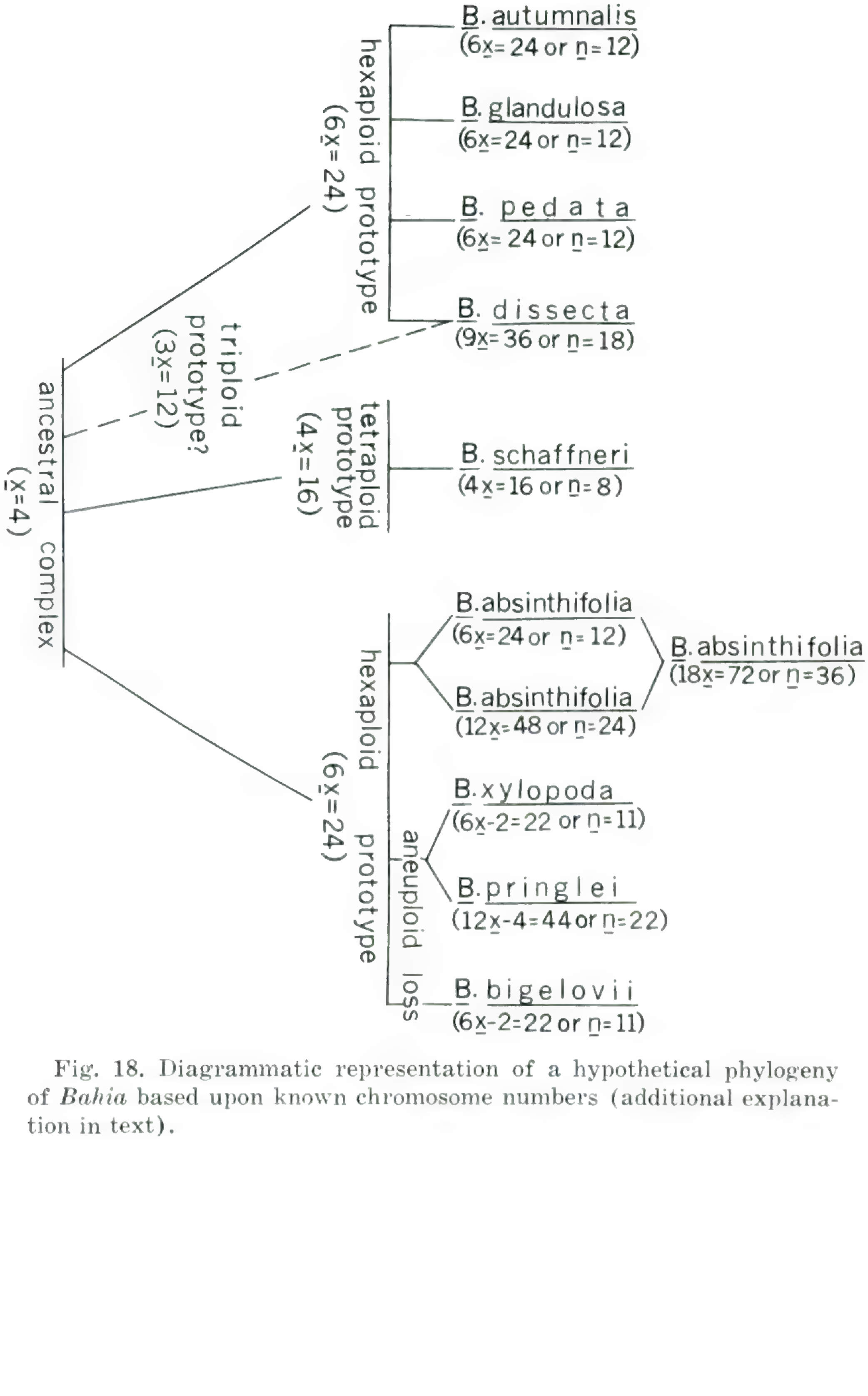

Fig. 18. Diagrammatic representation of a hypothetical phylogeny of *Bahia* based upon known chromosome numbers (additional explanation in text).

gibberellin per ml. water (Skinner, 1958). Following this treatment, the seeds were either placed directly in the petri dishes for germination, or dried and stored.

During the spring, some of the seedlings were transplanted to an outside garden and others were retained in the greenhouse. The following tests were applied: (1) self-sterility, (2) intra-specific and intra-varietal crosses, (3) inter-specific and inter-varietal crosses. Tests for self-sterility were made by bagging two heads before anthesis. If seeds formed in these heads, self-fertility was assumed. The intra-specific crosses were made to determine the effectiveness of the method employed in the inter-specific crosses.

Both the intra-/and the inter-specific crosses were made in the following manner. Heads were bagged while in bud and were left in the bags except at the time of crossing. The heads of two individuals were gently rubbed against one another on three different occasions (normally at daily intervals) as maturation of the florets progressed centripetally. Embryo development in four seeds or more in a head was interpreted as indicating a successful cross in taxa which were consistently found to set no seeds in previously determined self-sterility tests. Because of the occasional seed formation in presumed self-sterile plants (rarely 1 or 2 in a head), the results of the crosses should be interpreted with caution.

Results. Self-fertility tests: *B. absinthifolia, B. schaffneri* and *B. pedata* were found to be self-sterile or nearly so. *B. bigelovii, B. autumnalis* and *B. dissecta* were more or less self-fertile. The degree of self-fertility in these latter three taxa is summarized in Table II. The numerator and denominator in each ratio represent, respectively, the summation of the seed-set and the number of florets in two heads. As may be noted, 3 individuals of *B. bigelovii* and 4 individuals each of *B. autumnalis* and *B. dissecta* were tested.

Only one intra-specific or intra-varietal cross was made per taxon. This being the case, it is obvious that the results will be in the form of a doublet since each of the two heads used in the cross was examined for seed-set. The results

obtained are shown in Table III. No explanation is offered for the low seed-sets (particularly that of *B. absinthifolia* var. *absinthifolia*), though methodology and environmental conditions may have been contributory. It should be noted that the intra-specific percentage seed-set in *B. autumnalis* (and in *B. bigelovii* to a lesser degree) is significantly higher than the maximum seed-set in the tests of self-sterility. This is not true of *B. dissecta*, the percentage seed-set actually being higher in the self-fertility tests.

TABLE II. Results of Self-fertility Tests in Three Species of *Bahia*.

Species	Collection Number of Seed Source	Ratio of Seed-Set/Total Number of Florets
B. bigelovii	*E. & T. 19*	0/120 (= 0%); 0/162 (= 0%); 16/144 (= 11%)
B. autumnalis	*Johnston 4616*	2/338 (= 0.6%); 14/348 (= 4%) 14/244 (= 10%); 50/252 (= 20%)
B. dissecta	*E. & T. 22*	122/194 (= 63%); 154/220 (= 70%); 154/216 (= 71%); 190/234 (= 81%)

The data on the inter-specific crosses is summarized in Fig. 19. Two crosses between any two given taxa were made in every case. A diploid self-sterile *B. absinthifolia* var. *dealbata* (*n* = 12, *E. & T. 28*) appears here for the first time as I had only a single individual with which to work. The percentages refer to the female parent, and were calculated as follows:

$$\frac{\text{number of seed-set}}{\text{total number of florets}} \times 100$$

When no number appears, zero seed-set (rarely 1 or 2 seeds) is to be assumed. In all instances, the arrows point to the female parent. Solid lines graphically indicate the percentage seed-set in presumably successful crosses. Dashed lines indicate either the complete failure of seed-set, or, in the cases of *B. bigelovii*, *B. autumnalis* and *B. dissecta*, a seed-set equal to or less than their respective maximum seed-

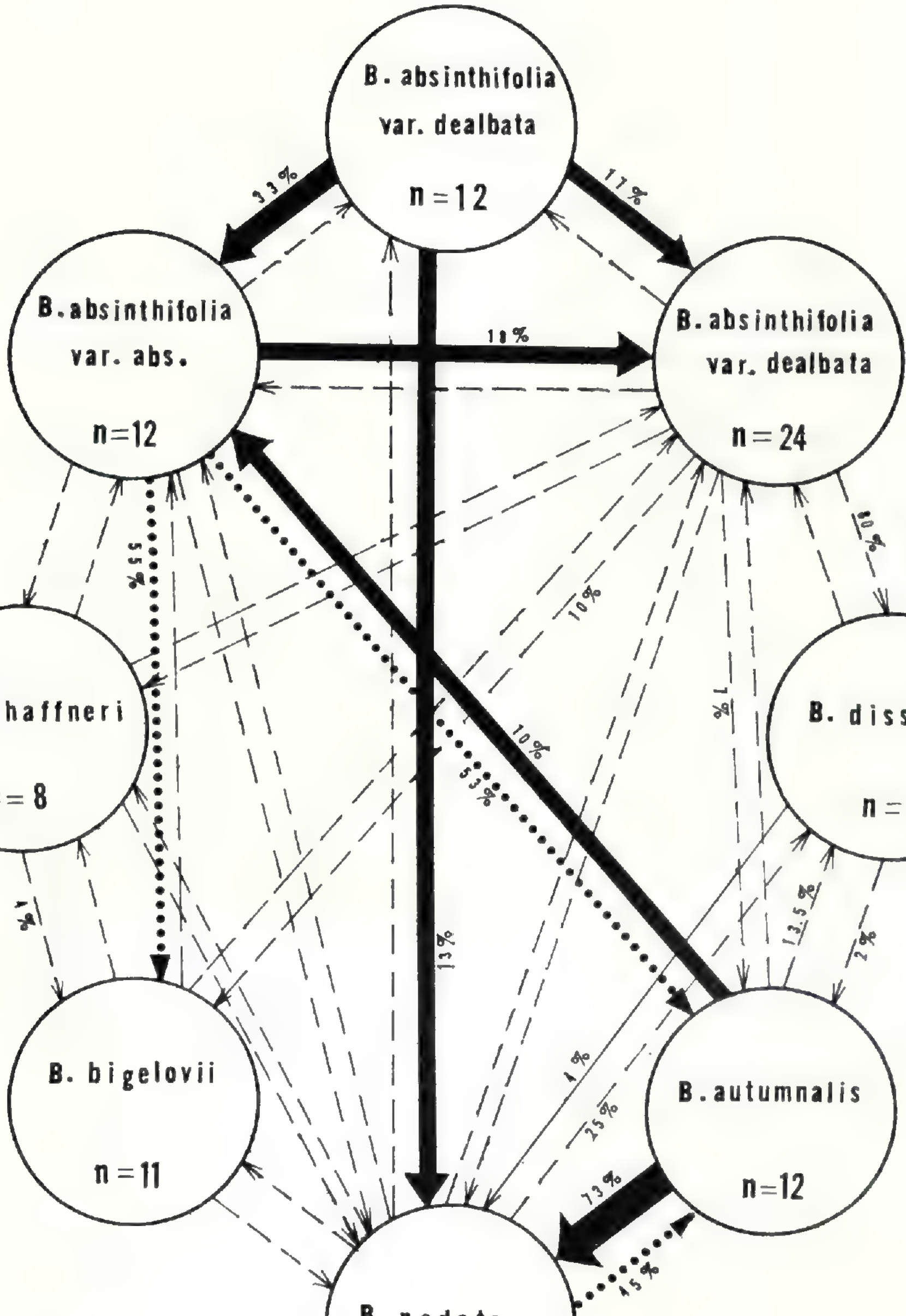

Figure 19. Inter-specific and inter-varietal tests of fertility in the genus *Bahia*. Solid lines denote significant seed-set in presumably successful crosses. Dashed lines indicate either complete failure of seed-set or a percentage which gave no positive evidence of crossability. Dotted lines denote dubious but possibly successful crosses (additional explanation in text).

TABLE III. Results of Intra-specific and Intra-varietal Crosses in 7 Taxa of *Bahia*.

Taxon	Collection Number of Seed Source	Per Head Ratio of Seed-Set/Total Number of Florets
B. absinthifolia var. *absinthifolia* ($n = 12$)	*Johnston 4214B*	0/52 (= 0%); 5/54 (= 9%)
B. absinthifolia var. *dealbata* ($n = 24$)	*E. & T. 15* / *E. & T. 34*	32/85 (= 38%); 33/116 (= 28%)
B. schaffneri	*Johnston 4029A*	4/53 (= 8%); 11/45 (= 25%)
B. bigelovii	*E. & T. 19*	14/89 (= 16%); 24/44 (= 55%)
B. pedata	*E. & T. 16*	12/116 (= 10%); 35/92 (= 38%)
B. autumnalis	*Johnston 4616*	121/166 (= 73%); 113/135 (= 84%)
B. dissecta	*E. & T. 22*	35/114 (= 30%); 84/106 (= 79%)

set as determined in the tests of self-sterility. The dotted lines indicate doubtful, but possibly successful, crosses in which the seed-sets were greater than those determined for these taxa in the self-sterility tests. For example, in the cross between *B. absinthifolia* var. *absinthifolia* and *B. autumnalis*, a seed-set of 10% in the former taxon was interpreted as being successful since *B. absinthifolia* had been shown to be consistently self-sterile. On the other hand, a 53% seed-set in *B. autumnalis* was interpreted as being only possibly successful because self-fertility percentages as high as 20% (see Table II) had been found for this taxon.

The supposed hybrid seeds, saved for future study, failed to germinate. A lapse of approximately 15 months intervened between harvesting the seeds and planting them. Thus, final verification of the results of the crosses is lacking.

CHROMATOGRAPHIC STUDIES

Chromatographic patterns have been utilized in recent studies as possible indicators of species affinities. A quantitative expression of such data has been made with reference to the genus *Bahia* (Ellison, Alston and Turner, 1962). The reader is referred to this publication as well as to the doctoral thesis of the writer (Ellison, 1961) for detailed information on collection and chromatography of the plant

material, calculations and methods of presentation of the chromatographic data, and taxonomic interpretations of these data.

LEAF STUDY IN BAHIA ABSINTHIFOLIA

Leaf shape has been used by most workers as the most conspicuous of several characters for the separation of *B. absinthifolia* var. *absinthifolia* and *B. a.* var. *dealbata*. No population work having been conducted with respect to this character, it was thought early in this study that an investigation of leaf profiles would be helpful in determining not only the existing variability, but also the validity of the profiles in distinguishing between the two taxa.

Methods. A single leaf from the second internode below a mature inflorescence was taken from each of twenty plants in a population. The selection of plants was made in a "random" fashion so that the leaves might be as representative of the population as possible. Leaves were pressed, dried, and subsequently glued to cardboard. There was an attempt to place the leaves from each population in an order ranging from the simplest to the most complex. In some instances, due to the size of the leaves, the number used was necessarily reduced. In such instances near duplicates were deleted. In order that the profiles be clearly visible, the leaves themselves were covered with black india ink.

Population samples are arranged in a geographical fashion (Fig. 20-38), which, for the most part, conforms with the order of collection. Reference should be made to Fig. 39 for the locations of the populations considered.

Results. A number of facts are immediately discernible. One is the extreme variability of leaf width and dissection both within the species as well as within any given population. A second observation is that there are six populations (Figs. 20, 33, 35, 36, 37, 38) that show rather consistent broad-leaved segments. In addition, there is a correlative reduction in degree of segmentation. Reference to Fig. 39 indicates these collections are grouped in northern Mexico and western Texas. The remainder of the populations have more or less narrow-leaved segments and are generally more dissected. A basic similarity in all the populations is their

trifid nature, although simple entire leaves and other variations are common. An additional observation is that, within the above-mentioned six populations, there is, in most instances, at least one leaf pattern that is indistinguishable from one or more leaves in the narrow-leaved populations.

If one were to use leaf pattern alone for species distinction and employ selected single plants instead of populations, it is obvious that numerous taxa could be named. It is only by reference to populational patterns that meaningful biological decisions may be made. According to the present treatment, the six populations with the predominantly broad-leaved segments belong to *B. absinthifolia* var. *dealbata;* all others are *B. absinthifolia* var. *absinthifolia* with two notable exceptions, these being the samples represented by Figures 32 and 34. These samples were taken from what appeared to be intermediate populations of the two varietal taxa.

It is suggested that future single collections of these taxa include at least a few additional comparable leaves from various plants in the population so that the range of variation may be more apparent. To do so will aid immeasurably in rendering taxonomic decisions.

MORPHOLOGY AND TAXONOMIC CRITERIA

There are various salient features and combinations of characters that are useful in the circumscription of the species and varieties. Whereas full appreciation can come only from actual work in the field and study of herbarium material, a brief descriptive appraisal of the basic morphological features which mark *Bahia* is desirable.

HABIT. Species of series Alternifoliae are tall, erect, alternately leaved annuals or biennials. Those of series Oppositifoliae are shorter, erect to decumbent annuals or perennials with most or all of the leaves opposite.

ROOT. Perennial species have woody rootstocks which may or may not bear adventitious shoots. Annual and biennial species have taproots which normally bear single crowns at their apices. The roots of the perennial species are particularly diagnostic; special care should be taken in the collection of specimens in order that the rootstocks be included.

LEAVES. Leaf characters alone are adequate to differenti-

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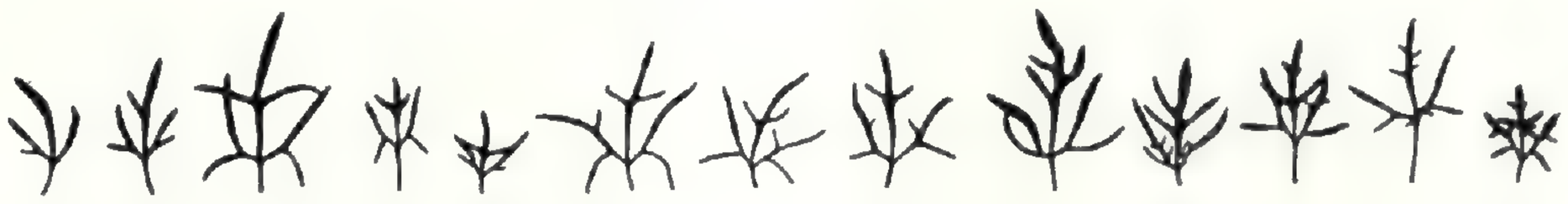
24. 

25.

26.

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29.

Fig. 20-29. Selected leaves from various populations of *B. absinthifolia.* (See Fig. 39 for the geographical locations of the collections.) All ca. × ½. *B. a.* var. *dealbata:* Fig. 20, *E. & G. 48.* *B. a.* var. *absinthifolia:* Fig. 21, *E. & G. 50;* Fig. 22, *E. & G. 56;* Fig. 23, *E. & G. 58;* Fig. 24, *E. & G. 64;* Fig. 25, *E. & G. 70;* Fig. 26, *E. & G. 108;* Fig. 27, *E. & G. 112;* Fig. 28, *E. & G. 114;* Fig. 29, *E. & G. 116.*

Fig. 30-38. Selected leaves from various populations of *B. absinthifolia.* (See Fig. 39 for the geographical locations of the collections.) All ca. × ½. *B. a.* var. *absinthifolia:* Fig. 30, *E. & G. 127;* Fig. 31, *E. & G. 130. B. a.* var. *absinthifolia* > *dealbata:* Fig. 32, *E. & G. 135;* Fig. 34, *E. & G. 153. B. a.* var. *dealbata:* Fig. 33, *E. & G. 138;* Fig. 35, *E. & G. 166;* Fig. 36, *E. & T. 27;* Fig. 37, *E. & T. 13;* Fig. 38, *E. & T. 42.*

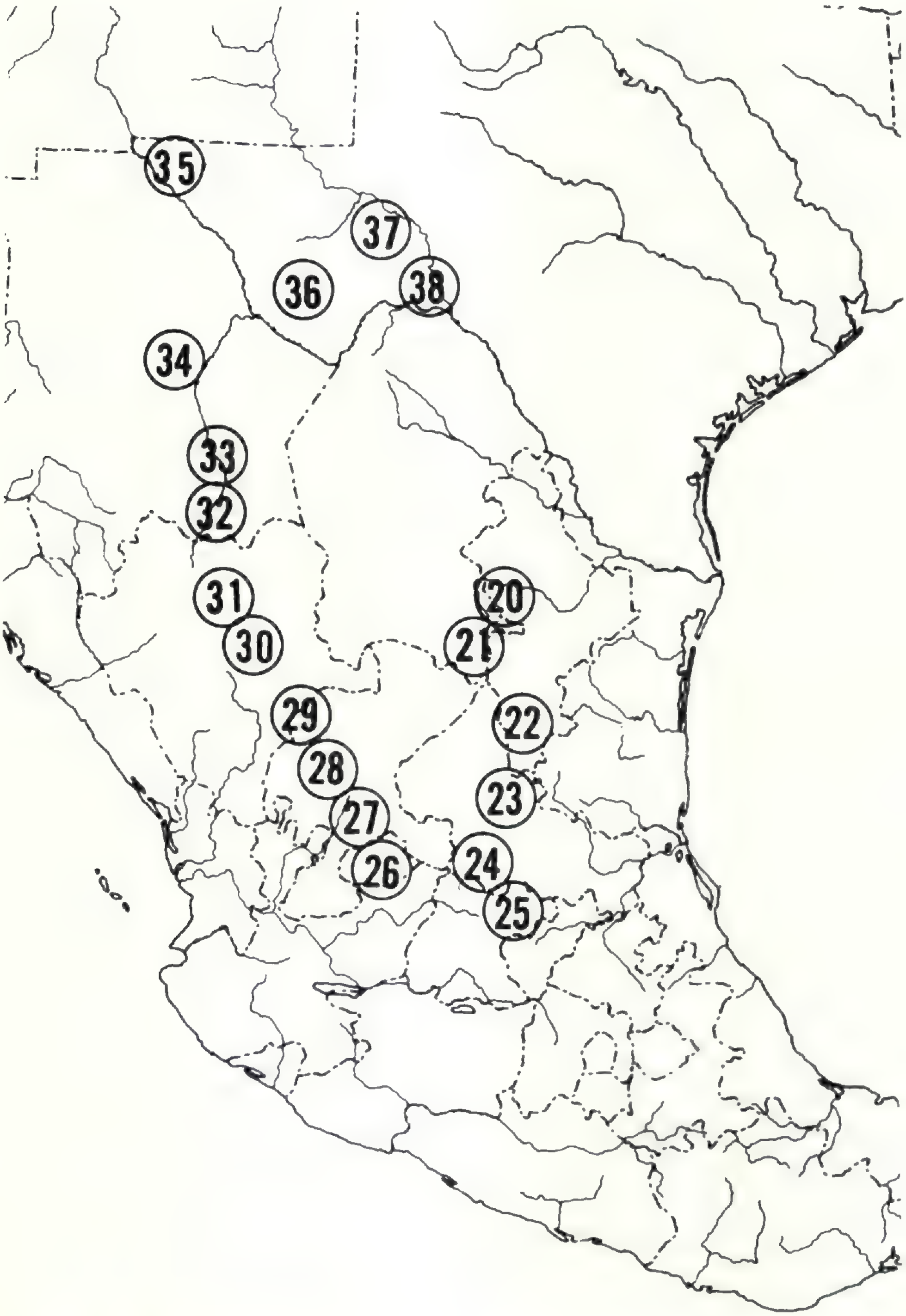


Fig. 39. Map showing locations of populations of *B. absinthifolia* var. *absinthifolia* and var. *dealbata* used in leaf study. (The numbers refer to Figs. 20-38).

ate between series Alternifoliae and series Oppositifoliae as well as to make certain specific determinations. The basic leaf pattern for the genus is trifid, although simple linear leaves occur on basal parts of some individuals in the species of the latter series.

INFLORESCENCE. All species have paniculate-cymose inflorescences with few to many heads.

HEADS. Only radiate heads are found in the genus. The size of the heads, number of disc and ray florets and, in some instances, the size and shape of the involucral bracts serve as distinguishing characters.

FLORETS. The disc corollas in all species are more or less broadly campanulate or funnelform and yellow or orange in color. The shape and size may be used as diagnostic features in certain species. With the exception of two taxa with white ray florets (one in each of the two series) all have yellow rays.

SUPERFICIAL PROCESSES. Pubescence and stipitate glands are of considerable taxonomic significance within the genus. One species in series Oppositifoliae can be identified on the basis of the degree of leaf pubescence alone, and stipitate glandulosity plus pubescence on vegetative parts is of considerable value in differentiating between some of the species in series Alternifoliae. Stipitate glands are present on the tube of the disc florets in all species and are of little value in the circumscription of the species.

ACHENES. All achenes in the genus are 4-sided and obpyramidal, although the peripheral ones are frequently somewhat incurved. Particular importance is attached to the number and shape of the pappus scales, and, in one species, to their predominant absence. Achenal pubescence and glandulosity are quite significant in the identification of certain taxa when used in conjunction with other characters.

STYLE BRANCHES. All style branches in the genus are flattened, having prominent marginal stigmatic lines and obtuse papillose appendages at their apices.

(To be concluded)

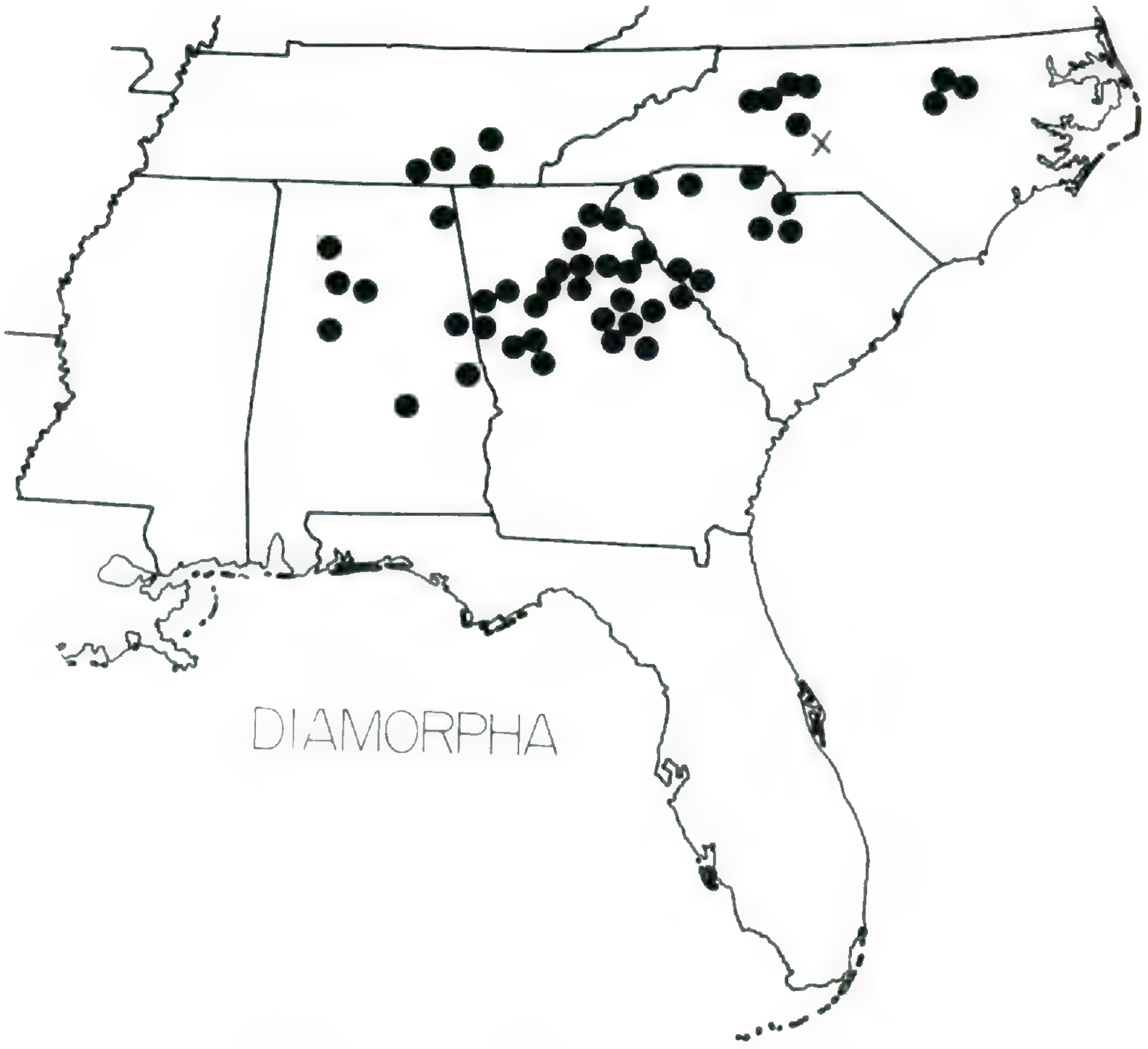
NOTES ON THE GENUS DIAMORPHA (CRASSULACEAE)

ROBERT L. WILBUR[1]

One of the most striking plants of the southeastern United States is the crassulacean taxon long known as *Diamorpha cymosa*. This small plant occurs on mineral soil in shallow depressions on the principally granitic outcrops from North Carolina and southeastern Tennessee south into Georgia and Alabama (Map 1). The distinctive red color of the leaves and stems of the plants, together with the large numbers of individuals closely aggregated in depressions upon these barren outcrops, attracts the attention of even the most casual observer. It is therefore surprising to learn that this species was apparently overlooked by the Bartrams and Michauxs as well as all the other early botanists known to have visited some of the very outcrops upon which the genus is known to occur.

Thomas Nuttall apparently was the first both to encounter the plant and to comment upon its distinctive botanical features. He collected it in fruiting condition while visiting the outcrop north of Camden, South Carolina in late 1816 or very early 1817. Nuttall, however, mistakenly identified the withered and dead fruiting specimens with Michaux's brief description of *Sedum pusillum* which Michaux had collected at the apparent same locality in 1795 and later described (Fl. Bor.-Am. 1: 276. 1803.) Nuttall first concluded (Gen. 1: 110. 1818.) that his plant (and what he presumed Michaux also to have had) was perhaps better placed in the genus *Tillaea* and he called it *"T ? *cymosa"* with *Sedum pusillum* appended parenthetically. Additional study having convinced Nuttall that this plant was generical-

[1]Grateful acknowledgment is made to the National Science Foundation (G-18799) and to the Duke University Research Council for the funds that made this study possible. I should like to express my gratitude to the curators of the herbaria indicated below by Lanjouw and Stafleu's abbreviations whose specimens, so generously loaned, formed the basis of this study: DUKE, GA, GH, NCSC, NCU, NY, PH, TENN, US.



Map 1. Distribution of *Diamorpha*.
(The X in central North Carolina marks the type-locality of *D. Smallii*.)

ly distinct from both *Sedum* and *Tillaea*, he proposed later in the same volume the name *Diamorpha* and then reverted inexplicably to Michaux's epithet in calling it *D. pusilla*. The two species remained undifferentiated until Asa Gray pointed out their numerous distinctions (Proc. Am. Acad. 11: 71-72. 1876.) after studying them both on Georgia's Stone Mountain in April 1875.

Michaux's and Nuttall's species were thereafter respectively known in botanical literature as *Sedum pusillum* Michx. and *Diamorpha pusilla* until sixty years ago when Small (Fl. Se. U.S. 498. 1903.) published the name *Diamorpha cymosa* attributing it to Britton. This nomenclature was employed by Britton in his treatment of the genus (N.

Am. Fl. 22: 56. 1905.) at which time he proposed *D. Smallii* as a second species in the genus. It supposedly differed from the earlier species in possessing "ovate-oblong" petals 2-2.5 mm. long and only "about twice as long as wide" in contrast to the "oblong" petals of *D. cymosa* which reputedly are 3 mm. long and "about three times as long as wide". *D. Smallii* was at that time known only from Small's collection made in late April at the "Falls of the Yadkin River, Stanley Co., North Carolina." Since then, no other specimens have been reported as belonging to that taxon. Small accepted this second species (Man. Se. Fl. 558. 1933.) and the differences claimed by him to differentiate the two species are summarized in the key presented below.

Petals elliptic, about twice as long as wide, 3-3.5 mm. long; carpels lanceolate, long-tipped; sepals about 1 mm. long ..... *D. cymosa.*
Petals ovate; slightly longer than wide, 2-2.5 mm. long; carpels ovoid, short-tipped; sepals about 0.5 mm. long ..... *D. Smallii.*

McVaugh (Ecol. Monogr. 13: 155. 1943.) concluded that *D. Smallii* "appears to be no more than a form of *D. cymosa.*"

An examination of the type of *D. Smallii* (and the only collection seen by me that either Britton or Small indicated as belonging to that species) shows it to possess only relatively immature flowers whose petal dimensions can be matched in shape and size with those of specimens of a comparable age from elsewhere within the range of the genus. The petals, as is to be expected, elongate with increasing age. The other supposed characters all seem to be such that could be expected to change with age or to fall within the range of variation within the species. There appears to be no basis whatsoever for recognizing a second taxon of *Diamorpha*. An attempt to relocate *Diamorpha Smallii* at or near its type locality in May 1963 was unsuccessful and it would appear that the power dams erected there have in all probability destroyed the site.

Unfortunately the nomenclature of this species still remains beclouded by the original confusion with *Sedum pusillum* which marred its botanical debut. As recounted above, Nuttall first (Gen. 1: 110. 1818.) published it as "*T* [*illaea*]? **cymosa* (*Sedum pusillum* Mich.)" Even though we now

know that Nuttall was mistaken in equating his plant with the succulent found by Michaux at the same locality, Article 63 of our current Code clearly specifies a name so published to be illegitimate since it was "nomenclaturally superfluous when published." Nuttall's second name (Gen. 1: 293. 1818.), *Diamorpha pusilla*, was merely a transfer of Michaux's epithet which was cited in synonymy and hence can not be employed since its type is another species. And similarly Small's publication of *D. cymosa* was also a transfer since Nuttall's name is employed parenthetically and "*D. pusilla* Nutt." added in synonymy. If Small had not indicated this by the parenthetical inclusion of Nuttall's name, one could then have treated *Diamorpha cymosa* as a new name in accordance with Article 72 of our present Code. Since Small clearly indicated, however, that a transfer was made, we can scarcely reach any other conclusion.

The valid name for this southeastern species must therefore be *Diamorpha Smallii* Britton. Its synonymy is summarized below.

Diamorpha Smallii Britton, N. Am. Fl. 22: 56. 1905.

Tillaea ? cymosa Nutt., Gen. N. Am. Pl. 1: 110. 1818. *nom. illegit.* Art. 63. (*Sedum pusillum* Michx., included as a synonym.)

Diamorpha pusilla (Michx.) Nutt., Gen. N. Am. Pl. 1: 293. 1818 as to plant intended but excluding its basionym, *S. pusillum* Michx.

Diamorpha cymosa (Nutt.) Britt. ex Small, Fl. Se. U. S. 498. 1903.

Sedum cymosum (Nutt.) Fröderström, Acta Horti Gotob. 10: App. 137. 1936.

Sedum cymosum var. *Smallii* (Britt.) Fröd., Acta Horti Gotob. 10: App. 138. 1936.

One perhaps should be more willing to accept the views of Fröderström, a monographer of *Sedum*, who considered that *Diamorpha* together with *Sedum Nuttallianum* Raf. and *S. pusillum* Michx. (= *Tetrorum pusillum* (Michx.) Rose) comprised a group of closely related American species. Even Berger (Nat. Pflanzenfam. 2 Aufl. 18a: 463. 1930.), whose general account of the entire family certainly entitles him to a respectful hearing, admitted, although accepting *Diamorpha* as a ditypic genus, that it might better be included within *Sedum*. ("Die Gattung ist vielleicht besser zu *Sedum* zu stellen.") Generic limits within the Crassulaceae

are notoriously difficult to delimit but at the present state of our knowledge little would be gained and perhaps something lost if one were to stretch even further the limits of the exceedingly diverse genus *Sedum*. In spite of its great diversity, the carpels of all true Sedums apparently dehisce along the ventral (= upper) suture which contrasts greatly with the large elliptic to tear-shaped flap that splits off of the dorsal surface of each carpel of *Diamorpha*. This unique extrorse dehiscence of the united carpels seems to be a feature of such profound importance that generic status ought to be accorded to *Diamorpha* at least until a more satisfactory demarcation of genera within the family is presented. Cytological evidence has also been presented in support of the generic status of *Diamorpha*. Baldwin (Madrono 5: 184-192. 1940.) reported the chromosome numbers of the three species of Crassulaceae mentioned here to be: *S. pusillum*, n = 4; *S. Nuttallianum*, n = 10 and *Diamorpha*, n = 9. He thought it reasonable that *Diamorpha* was an amphidiploid result of "fusions between the 4- and 5- chromosome tendencies" within *Sedum*. Baldwin concluded that *Diamorpha* was a "good" genus and that its "chromosome number appears to be unusual for the family, and that number is inferred to be the doubled product of the fusion between representatives of two different evolutionary streams."

Wiggs and Platt (Ecology 43: 654-670. 1962.) in an extensive study of the ecology of this succulent have concluded that an important adaptation of this species for survival is the retention of its seeds within the capsule several inches above the high surface temperatures of the shallow depressions. The seeds, according to their report, are not released "in the late summer and fall until the continued action of moisture brings about a breakdown of lateral sutures on the dorsal lip of the follicles, a process requiring 2-5 months." [Actually, as pointed out long ago by Torrey & Gray (Fl. N. Am. 1. 561. 1840.), the fruits are "not dehiscent by either suture, but by the vertical separation of the dorsal portion (nearly half) of each carpel in a valvular manner."] It

was hence observed with some surprise that all plants on the outcrops in eastern Wake County, N. C. early in June had shed their seeds. Observation upon numerous herbarium specimens from throughout the range of the species indicate that in most cases the seeds have been shed by very early summer if not in the late spring. It hence would appear that seed-retention for 2-5 months after the death of the plants is of no particular survival advantage to the species and is indeed not characteristic of at least most populations of the species.

DEPARTMENT OF BOTANY, DUKE UNIVERSITY

FLORA OF MISSOURI[1] [2]

It would seem at first glance that hardly anything that might be looked for in a state flora has been left out of this vast work. On the basis of size one is reminded of Deam's *Flora of Indiana* but in many respects Dr. Steyermark's is a much more detailed study. Deam's was the result of long experience. This too represents nearly thirty years of progress on the Missouri flora since the publication in 1935 of E. J. Palmer's and Steyermark's *An Annotated Catalogue of the Flowering Plants of Missouri.* Twenty years ago many of us thought that Deam had achieved the ultimate in state floras, at least as compiled by one person. One is led to wonder if any individual botanist of the future will have the time, energy, ability, and inclination to surpass for any other state the work under review. Indeed, one might raise a question concerning the advisability of preparing similarly compendious treatments of adjacent states now that Missouri is so well done. Inevitably there would be much

[1]Flora of Missouri by Julian A. Steyermark, Iowa State Univ. Press, Ames, Iowa. LXXXIII + 1725 pp. Nov. 1, 1963, $18.50.

[2]We have been asked by the publishers to advise our readers that the date of publication was omitted from approximately the first 150 copies of the *Flora of Missouri.*

repetition of illustrative material, discussions and keys involving many of the same taxa.

After a lucidly written preface and introduction, there is a section of several pages entitled, "Flora and Vegetation" the emphasis here being on the characterization of floristic regions of the state. Future workers will be directed in their collecting by consulting the extensive lists, at the close of this section, of taxa that are known to occur nearby in adjacent states but have not yet been found in Missouri.

A general key occupying about 50 pages follows with a *List of Champion Trees in Missouri* completing the introductory remarks. The latter will be interesting to the vast audience of tree lovers.

The main body of the flora extends for 1654 pages. Extensive and elaborate keys to genera and lower taxa essentially take the place of detailed descriptions though critical characters frequently are mentioned under the species. Careful attention is given to the range and habitat in the state for each taxon and a range map is included. These may seem unnecessary for the many species having solitary or few stations since there is a county map of Missouri in the preliminary part of the book (on p. XXIX) and, in general, the counties are given in the text for rare or localized species. A valuable feature of the book is the inclusion of synonyms in cases of likely confusion. One of the most interesting aspects about the book is the rather frequent commentary on such matters as economic uses, salient points for recognition, notes on special habitat features, as well as the author's personal experience with the plants in question. These reveal, as nothing else can do, the author's competence for the task. Much of this discussion is interesting, highly informative, and doubtless will prove invaluable to students of the plants in question wherever they grow.

In general Steyermark must have followed the progress of taxonomic revision faithfully to bring the treatment up to date. The reviewer has not been able to find any references to special treatments nor is there a section devoted to bibliography. This omission seems to reflect Steyermark's

evident intention to assume responsibility, in nearly all instances, for the particular way each group is treated.

The illustrations include a large percentage of the taxa. They are all line drawings and seem to be particularly well done. On the large pages they mostly stand out very clear. The author wisely, when good illustrations have been available, has borrowed them with due acknowledgment. Usually they are placed near to the keys and descriptions but a minor deficiency is the lack of any reference to a figure in the keys or the writeup.

A comment which could apply equally to certain other recent floras or manuals concerns the handling of the two genera, *Crataegus* and *Rubus*. In *Crataegus*, Steyermark has followed recent custom and doubtless his own inclination in accepting the treatment of Dr. E. J. Palmer. The result is a sizeable aggregation of 50 species and many varieties. In *Rubus*, he seems to have done considerable pruning away of superfluous taxa much as Gleason and Cronquist did in their recent manual but nonetheless accepting some ideas about the blackberries from Fernald in Gray's Manual. One might hope that someone will make a more realistic treatment of *Crataegus*.

Certainly in most respects here is a magnificent state flora of about the magnitude of a manual. Dr. Steyermark is to be congratulated for having completed such a monumental task.

A. R. Hodgdon, university of new hampshire

HYDRASTIS CANADENSIS L., IN NEW ENGLAND

Leopold A. Charette

The Golden Seal or Orange Root is a rare plant in New England where it attains its northeasterly limits of distribution in Vermont and Connecticut.

In Connecticut it is recorded in the literature (Bissell 1900, Knowlton et al. 1918 and Bean et al. 1960) from the base of Meriden Mountain in Southington on the authority

of E. R. Newall in 1897 and in Plainville on the authority of J. N. Bishop.

In Vermont it is known from Shelburne and Weybridge (Brainerd et al. 1900, 1915; Flynn 1911, 1935 and Dole 1937). It is not known if these stations persist as the early botanists left no precise information which would enable succeeding botanists to relocate them and, from all indications, the colonies appear to have been very small. More recently the species was reported to me by Miss Joyce Bates of Burlington, Vt., as growing in considerable numbers at a station in Orwell. All of these Vermont stations border on, or are in very close proximity to the eastern shores of Lake Champlain. The record for this plant in Wells River cited by Dole (1937) is dubious inasmuch as it is unsupported by an herbarium specimen. As the Orwell station proves to be an extensive one wherein plants can be counted in the hundreds and represent the first collection of the species, in a wild state, in New England in sixty years it is deemed worthy of a special record.

On 18 May 1963, in company with Miss Bates and Mr. John Daniels, I visited the Orwell station. By actual pacing of the colony, located in a clearing of mixed wood dominated by beech and maple, it was found to occupy an area of 60 x 90 feet. At this time the plants were at the height of flowering and formed an exceptionally dense colony of a thousand or more plants, so crowded in fact as to form a solid carpet of green. This colony has been known to Mr. Daniels for at least forty years and was known to his father before then. Mr. Daniels (1963) knew this colony as a youth, and recalls that the plants seemed shorter and the colony smaller in extent. There are additional scattered plants in this rich woodland not too distant from the large colony and Mr. Daniels has knowledge of at least four smaller colonies in other woodlands within a radius of from two to four miles from this colony.

No information has been recorded in the literature on the station in Weybridge. The discovery of the station in Shelburne, which is credited to a "bulb collector", has been recorded in some detail by Brainerd (1899 and 1901).

VERMONT. CHITTENDEN Co.: Shelburne, 8 August 1899, E. Brainerd, (VT), warm woodlands, 19 May 1903, C. G. Pringle, (VT); ADDISON Co.: Orwell, 4 July 1962, Miss Joyce A. Bates and John Daniels, s.n. the 3rd definitely known station in Vermont, (VT, NEBC), 18 May 1963, L. A. Charette (No. 2552), Miss Joyce A. Bates and John Daniels. (VT). Weybridge, 29 July 1902, W. W. Eggleston No. 2882 (GH, VT), 10 May 1903, E. Brainerd, (VT). CONNECTICUT. HARTFORD Co.: Plainville, rocky woods in rich soil, 12 May 1918, C. H. Bissell, (YU), rich woods along talus slopes, 8 May 1921, G. E. Nichols, (YU). Southington, rocky woods, rare, from foot of Hanging Hills off Savage St., 30 June 1898, C. H. Bissell, (YU), from plants in grounds of E. R. Newall of which roots had been transplanted from rich woods, 15 May 1899, C. H. Bissell, (YU). FAIRFIELD Co.: Easton, rich rather dry upland woods, well established from cultivated area, 9 July 1932, H. H. Taylor, (YU).

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REFERENCES CITED

BEAN, R. C., A. F. HILL & R. J. EATON. 1960. Thirteenth Report of the Committee on Plant Distribution. Preliminary Lists of New England Plants — XXXVIII. Rhodora **62:** 108-116.

BISSELL, C. H. 1900. *Hydrastis Canadensis*, L., A New England Plant. Rhodora **1:** 157.

BRAINERED, E. 1889. *Hydrastis canadensis* in Vermont. Rhodora **1:** 200.

———. 1901. Twentieth Century History of Vermont — III. The Plants of Vermont. The Vermonter **5:** 84-97.

BRAINERD, E., G. L. KIRK & J. G. UNDERWOOD. 1915. Flora of Vermont. List of Fern and Seed Plants Growing Without Cultivation. Vt. Agric. Exp. Sta. Bull. 187: 140-258.

DANIELS, J. C. 1963. 2-paged autographed letter in MS to L. A. Charette dated at Essex Jct., Vt., 20 Jan. 1963. Pringle Herbarium Document 963-120-1.

DOLE, E. J. 1937. The Flora of Vermont. Third Revised Edition. An Annotated List of the Fern and Seed Plants of the State of Vermont. Free Press Printing Co., Burlington, 353 pages.

FERNALD, M. L. 1950. Gray's New Manual of Botany, American Book Co. 1632 pages.

FLYNN, N. F. 1911. Flora of Burlington and Vicinity. A List of the Fern and Seed Plants Growing Without Cultivation. The Free Press Printing Company, Burlington. Issued as Contribution to the Botany of Vermont — IX. 124 pages.

———. 1935. Same. Second Edition. 130 pages.

KNOWLTON, C. H., W. S. RIPLEY & C. A. WEATHERBY. 1918. Report of Committee on Floral Areas. Preliminary Lists of New England Plants — XXVI. Rhodora **20:** 181-185.

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Vol. 66 April-June No. 766

CONTENTS:

Francis Welles Hunnewell 1880-1964. *Reed C. Rollins* 97

Reproductive Biology of Piriqueta caroliniana (Turneraceae). *Robert Ornduff and James D. Perry* 100

Taxonomic Fern Notes. IV. Some American Vittarioid Ferns. *Rolla Tryon* 110

Plantae Colombianae, XVII. *Richard Evans Schultes* 118

The Genus Subularia (Cruciferae). *Gerald A. Mulligan and James A. Calder* 127

Note on Cimicifuga rubifolia Kearney in Virginia. *Gwynn W. Ramsey* 135

(Continued on Inside Cover)

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CONTENTS: — *continued*

A Hybrid Population of Claytonia in Virginia.
Leonard J. Uttal 136

Flora of the Wolf Islands, New Brunswick, Part II.
Albion R. Hodgdon and Radcliffe B. Pike 140

The Status of Aganippea bellidiflora (Compositae-Heliantheae). *A. M. Torres and J. H. Beaman* 156

Magnolia grandiflora in Gray's Manual Range.
A. M. Harvill, Jr. 159

Application of the Name Kuhnia eupatorioides var. angustifolia (Compositae). *Lloyd H. Shinners* 160

New Records and Notes on Plants of Kansas.
Larry J. Harms 161

A Rare Blue-Green Alga from Massachusetts.
Edgar E. Webber 163

Illinois Flora: Notes on Leptochloa and Lycopodium.
Robert A. Evers 165

Podophyllum peltatum f. Deamii from Bryan County, Oklahoma. *Constance and John Taylor* 167

On the Perianth and Seed Characters of Chenopodium hybridum and C. gigantospermum. *A. I. Baranov* 168

Plant Pressing with Plastic Sponges. *Radcliffe B. Pike* 172

A Systematic Study of the Genus Bahia (Compositae) *cont.*
William L. Ellison 177

A New Method for Mounting Evergreen Conifer Twigs with Deciduous Leaves. *A. J. Sharp* 216

Rhodora

JOURNAL OF THE

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FRANCIS WELLES HUNNEWELL 1880-1964

Botany was definitely an avocation for Francis Hunnewell and he was always careful to let it be known that he was not a trained botanist. In a way, this was pure modesty, the kind that characterized the man, for he not only knew a lot about plants but he worked with them intelligently for nearly sixty years. It was in 1913 that he became Phanerogamic Curator of the New England Botanical Club, a title he held until 1958. He had been elected to membership in the Club in 1912. This was a period when many Club members were assembling herbaria of their own. The stimulation provided by such men as M. L. Fernald, J. R. Churchill, C. F. Batchelder, S. N. F. Sanford, Ludlow Griscom and C. H. Knowlton produced a concerted and sometimes competitive effort in the collecting of specimens and the building of private herbaria. Hunnewell shared in this enthusiasm and before his collecting activities subsided, he had assembled an herbarium in excess of 20,000 sheets. Most of these were not local gatherings in New England, as were some of his friends' collections. He often went far away to do his botanizing. Notable collections were made in Chile, Argentina, Peru, Panama and several of the islands of the Caribbean area. His most intensive collecting was done in Virginia, where he spent several months in residence nearly every year, but he also collected extensively in West Virginia, Colorado, Yellowstone Park, and in the Rocky Mountains of Canada.

Nearly all of Francis Hunnewell's botanical activities had to do with field botany in one way or another. The building

of a private herbarium was one way of savoring again the pleasure he derived from getting the specimens in the first place. However, it was no joy to him to put someone else's specimens into his collection, for no image of the living plant or of its haunts was provided by the gatherings of others. As a result, his private herbarium held specimens collected only by himself. Even the fourteen short papers, mostly published in Rhodora, authored by Mr. Hunnewell, dealt with the geographical ranges and other field aspects of plants. Again a devotion to plants in the field is illustrated by his establishment of a permanent fund at Harvard to be used only for field work in systematic botany. His admiration of Professor Fernald was shown by his having asked that this fund be designated as the Fernald Fund.

Although he was devoted to Fernald and looked upon him with approval as a combined field naturalist and professional botanist, Mr. Hunnewell knew Professor Fernald well from other points of view. It is remembered how on one of several such occasions Mr. Hunnewell, with a wry and quiet sense of humor, kept Fernald from an inevitable attack on a certain author of whom he had frequently been critical. The incident involved a new book just off the press. Mr. Hunnewell's approach to Fernald was, "I've just read so and so's book and found it to be excellent and very informative. How do you like it?" Fernald's response is said to have been muffled and restrained. Later, out of Fernald's view and hearing, Mr. Hunnewell was observed to have derived some pleasure at having curbed somewhat the voluble expression Fernald was sure to have given had a less muzzling approach to the subject been made.

Around the Gray Herbarium, we were often to pick up the quiet humor Mr. Hunnewell possessed. He worked in the New England Botanical Club many, many hours over the years. From the time of his retirement as Club Curator to within a few months of his death, Mr Hunnewell spent much time checking the specimens of his personal herbarium against those in the Gray Herbarium to see whether they were needed. He often turned over, usually in small lots,

those he judged to be significant additions to the Gray collections. Those he felt were not required were sent to other institutions as gifts or in exchange. The primary recipients were the Virginia Polytechnic Institute (specimens from Virginia) and the University of Minnesota.

Francis Hunnewell was associated with Harvard University in one way or another from the beginning of his student days in 1899 until his death on January 15, 1964. He was retired from being a Research Associate of the Gray Herbarium in 1959, at his own request and insistence, but this made little difference in the frequency of his trips to the herbarium. Following graduation from Harvard College in 1902, Mr. Hunnewell took an advanced degree in the Law School. He practiced law for a number of years but in 1912 he became Comptroller of Harvard and then served as Secretary to the Corporation of the University until 1933. A thank you for devoted service came upon his retirement from that post in the form of an honorary masters degree from Harvard given from the hand of President Lowell. From then on, Mr Hunnewell began to devote more of his time to botany and, as a Research Associate of the Gray Herbarium, maintained his connection with the University.

Mr. Hunnewell would have been the last person to claim a place of recognition in botany yet he very definitely made a contribution of significance. His efforts supported others mainly, but his activities in the New England Botanical Club Herbarium were sustained and productive. The Club owes much to his diligence.

REED C. ROLLINS,
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REPRODUCTIVE BIOLOGY OF PIRIQUETA CAROLINIANA (TURNERACEAE)

ROBERT ORNDUFF AND JAMES D. PERRY

When Charles Darwin published his classic "Forms of Flowers" (1877) he summarized the information then available concerning heterostyly in various plant families. At that time the Turneraceae was missing from his list, although a few years later Urban (1883) reported that about 70% of the members of this family were distylous. Despite this early documentation of the prevalence of heterostyly in the Turneraceae, few investigations have been made on the reproductive method of any of its species.

The Turneraceae is the only family in the large Englerian order Parietales in which heterostyly seems definitely to be present, although there is an unconfirmed report for the Guttiferae (Thiselton-Dyer, 1872). Because of the isolated occurrence of floral heteromorphism in this order, an investigation of the breeding system of heterostylous species of Turneraceae is warranted. Furthermore, certain authors have described each of the floral forms of heterostylous species in other families as separate species (discussed by Hildebrand, 1866; Ray and Chisaki, 1957). Other authors have misinterpreted floral dimorphism as dioecism (Darwin, 1877). Our purpose, therefore, is to record our observations on the reproductive biology of *Piriqueta caroliniana*, to establish that both flower forms belong to the same species, and to demonstrate that both are necessary for sexual reproduction to occur.

Piriqueta caroliniana (Walt.) Urban is a polytypic species which occurs in South America, the West Indies, and the southeastern United States. At least 4 of its described varieties occur in Florida, but the only variety we have investigated is *P. caroliniana* var. *caroliniana*, which occurs as far north as South Carolina. There is a report of the species in North Carolina (Urban, 1883, and subsequent authors), but we have seen no specimens collected or definitely cited from that state.

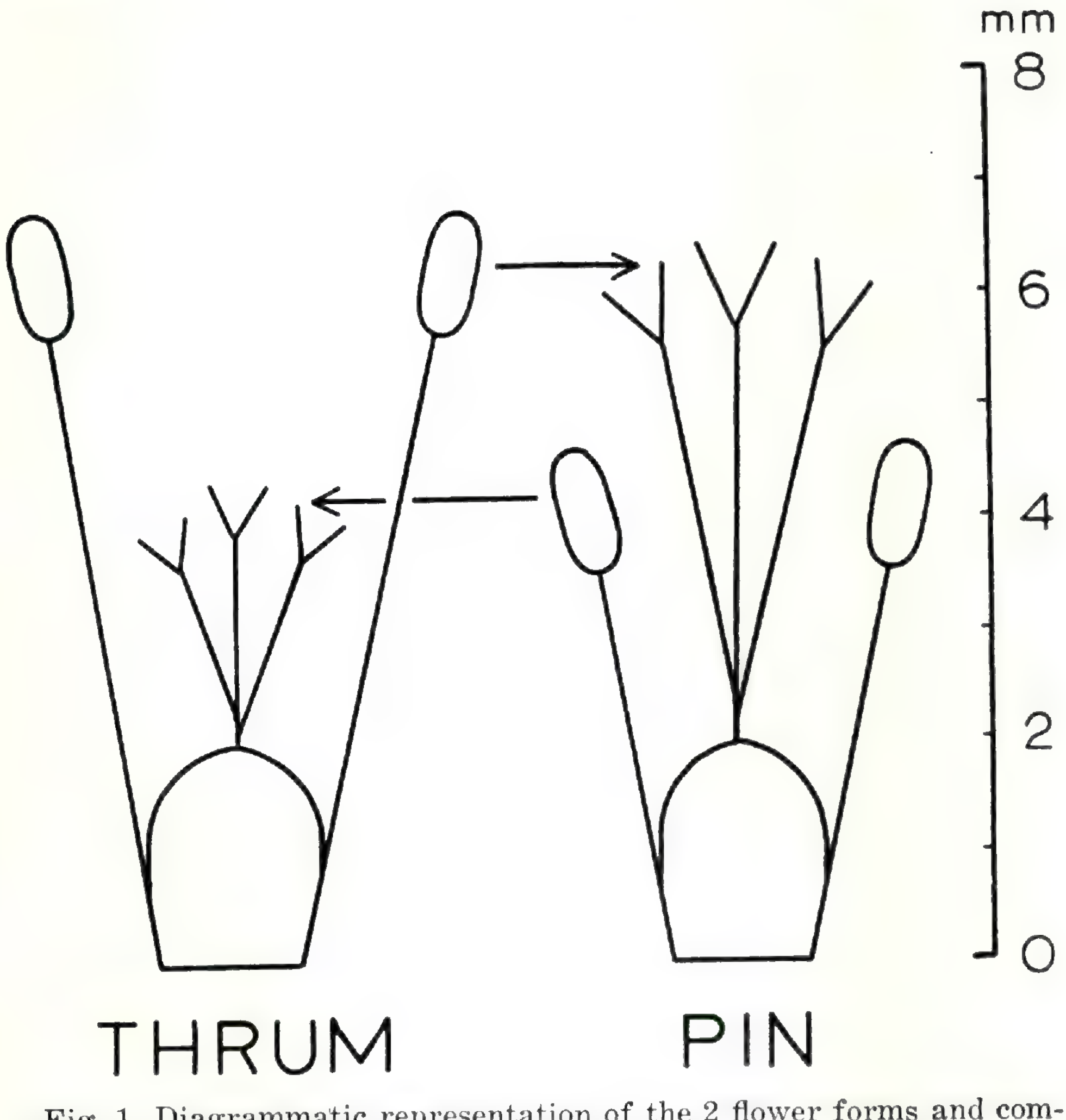

Fig. 1. Diagrammatic representation of the 2 flower forms and compatibility relationships of *Piriqueta caroliniana*. Arrows from anthers to stigmas indicate the direction of the most compatible crosses. All other pollinations are comparatively incompatible.

The species occurs in sandy soils of dunes, open pine or hardwood forests, and grassy areas of the Coastal Plain. Flowering begins in late spring and continues through the summer, although specimens from Florida apparently produce occasional flowers at almost any time of the year. The golden-yellow corollas open in early morning and remain open until mid-afternoon, at which time they close and wither. The plants are long-lived perennials which reproduce not only by seed, but by means of numerous shoots which develop vegetatively from the roots, often at a con-

siderable distance from the parent plant. The arillate seeds are probably dispersed by ants (Brizicky, 1961). In areas where it is abundant, *P. caroliniana* forms large and showy colonies.

Two kinds of plants occur in populations of *P. caroliniana*. One of these bears flowers with long styles and short stamens ("pin" flowers) and the other bears flowers with short styles and long stamens ("thrum" flowers, Fig. 1). Early observers considered floral dimorphism (in other families) to be a structural adaptation which promotes cross pollination. Insects visiting these flowers would carry pollen from the high anthers of one flower to the high stigma of another, and from the low anthers to low stigmas. When several of these species were investigated it was demonstrated that incompatibility systems promoting outbreeding were usually associated with this floral heteromorphism (Darwin, 1877). Thus, what was originally a morphological term (heterostyly) acquired physiological connotations as well. There are, however, numerous examples known in which heterostyly is not associated with an incompatibility system, so that outbreeding in these species must depend primarily on the positional relationships of the anthers and stigmas of the different flower forms. We have attempted to determine both the morphological and physiological features of distyly in *P. caroliniana*.

Measurements of floral parts of preserved flowers and of fresh pollen grains mounted in lacto-phenol are given in Table 1. These figures indicate complete dimorphism of *P. caroliniana* with respect to style length, stamen length, and size of pollen grains. Particularly noteworthy is the good reciprocal correspondence in the heights of anthers and stigmas of the 2 forms (Fig. 1). Occasional overlap in individual measurements for the height of these organs in the 2 forms occurred, but the averages and modes are distinct. Average pollen-grain diameter of the thrum flowers is 13.8μ greater than that of the pin flowers. Although substantial overlap in individual measurements of pollen grains occurred, the average figures for the 15 pin plants and the 10 thrum plants sampled were mutually exclusive for the 2 forms.

Table 1. Measurements of floral parts and pollen grains of *Piriqueta caroliniana* var. *caroliniana*

Form	Height (mm) of stigma above ovary base	Height (mm) of anther above ovary base	Pollen grain diameter (μ)
Long	6.4 (5.0-8.0)	4.5 (4.0-5.5)	59.4 (52.0-72.8)
Short	4.2 (3.5-5.0)	6.9 (5.0-8.0)	73.2 (62.4-83.2)

In a distylous species, the possible pollinations which may occur are (1) self-pollinations or own-form pollinations between different plants of the same floral form and (2) cross pollinations between the 2 floral forms. Pollinations in the first category are termed "illegitimate" and the second are "legitimate" (Darwin, 1877). Plants of *P. caroliniana* were transplanted to the Duke University greenhouses from populations in Allendale and Orangeburg counties, South Carolina. An extensive crossing program was carried out with these plants to determine the pollen-carpel compatibility relationships in the 2 forms. Numbered plants were placed in insect proof cages and artificially pollinated in various combinations. Records of capsule and seed production of individual plants were kept, but the results of each type of cross have been combined and presented in summary form (Table 2). While the results of these pollinations are valid for comparative purposes, it should be mentioned that the low percentage of capsules produced by the most fertile crosses must be attributed to pollinations carried out near the end of the flowering season of the plants. When it was realized that none of these late pollinations resulted in fruit production, the program was stopped.

The data presented in Table 2 suggest that the pin plants are strongly self-incompatible, although crosses between pin plants resulted in the production of a small number of well-filled capsules. Additional self-pollinations using other plants may reveal a greater similarity between the results of self-pollinations and own-form pollinations in the pin plants. The results of illegitimate pollinations of the thrum plants indicate a moderately strong self-incompatibility of this form and suggest that thrums may be somewhat more self-compatible than are the pins.

Table 2. Results of legitimate and illegitimate pollinations of *Piriqueta caroliniana* var. *caroliniana*.

Type of cross (♀ × ♂)	No. of plants used as ♀	Number of flowers pollinated	Number of capsules produced	Number of capsules collected	Number of seeds collected	Per cent of flowers producing capsules	Average number of seeds per capsule collected	Average number of seeds per pollination
Long × Long	12	284	45	39	496	15.8	12.7	1.7
Long selfed	3	21	0	0	0	0	0	0
Long × Short	15	218	114	95	1874	52.3	19.7	8.6
Short × Short	12	215	57	47	584	26.5	12.4	2.7
Short selfed	6	52	14	9	117	26.9	13.0	2.3
Short × Long	10	141	86	69	1382	61.0	20.0	9.8

The legitimate reciprocal pollinations between pin and thrum plants provide a strong contrast to the illegitimate pollinations. These legitimate cross pollinations were highly productive of capsules and seeds. Furthermore, pin and thrum plants were similar in the proportion of flowers which produced capsules, in the average number of seeds per total pollinations, and in the average number of seeds per capsule. The results of the legitimate and the illegitimate crosses demonstrate beyond doubt that an incompatibility system is linked with distyly in *Piriqueta caroliniana*.

The results presented above attest to the efficiency of a physiological incompatibility system which prevents certain fertilizations from occurring, but they do not account for the means of pollination under natural conditions. In the field *P. caroliniana* is freely visited by bees which collect nectar and pollen from the flowers. The insects visiting a population in Orangeburg County, S. C., were collected by the first author in late May, 1962, and identified by Dr. T. B. Mitchell, emeritus professor of entomology at North Carolina State College.

The collection consisted almost exclusively of bees; no Lepidoptera or Coleoptera were seen visiting the plants and only a few Diptera were noted. The most common bee visitor to the plants was *Halictus ligatus* Say (Halictidae), a widespread bee known to pollinate a number of genera (Mitchell, 1960). Also observed, but less abundant than the preceding species, were *H. parallelus* Say, *Colletes brevicornis* Robt. (Colletidae), and the newly-described *Dialictus brassicae* Mitch. (Halictidae). It is probable that additional bee species and members of other insect groups accomplish pollination as well.

In order to make a final determination of the combined efficacy of the incompatibility system, the floral dimorphism, and the pollinators of *P. caroliniana*, the following simple experiments were carried out. A flat with 6 pots of pin plants was set outside the university greenhouses and, at the same time, another flat with 6 pots of thrum plants was put outdoors at a site separated from the greenhouses by

about 1300 meters of dense forest. The nearest known natural colony of *P. caroliniana* occurs 300 miles to the south. The plants in these flats were visited by numerous insects, particularly species of *Halictus*. At the end of 2 weeks the plants were examined for capsules. Although well over 100 flowers had been produced by each group, not one capsule had developed. After these observations were made, the pots of pin and thrum plants were placed together outside the greenhouses. At the end of 2 weeks every flower which had developed during this period produced a full capsule. The average seed number per capsule produced by this open pollination method was 21.1, which compares favorably with the figures we obtained from the artificial legitimate pollinations (Table 2). These results not only attest to the efficiency of the insect pollinators, but to the effectiveness of the floral structure and incompatibility system in preventing seed production from illegitimate pollinations.

In most distylous species which have been studied the style and stamen characters of the 2 forms are controlled by a pair of allelic supergenes (Lewis, 1954). The pin is *ss* and the thrum is *Ss*. Some *SS* thrum plants may also occur in some self-compatible heterostylous species as a result of self-pollinations (Ray and Chisaki, 1957). In certain members of the Plumbaginaceae, pins are the heterozygotes and thrums are the homozygotes (Baker, 1954). With either genetic system, enforced outbreeding between pins and thrums would result in a 1:1 ratio of the 2 forms in the progeny of either form. Therefore, in natural populations of distylous species where crossing is exclusively between the 2 forms, as it is in *P. caroliniana*, the population composition should be in the ratio 1 pin : 1 thrum.

Although the genetic basis of heterostyly in *Piriqueta* is still unknown, the following information is pertinent to its eventual determination. Seed obtained from a single thrum plant in the Orangeburg population was planted and the style length of its progeny recorded as they flowered. This progeny consisted of 34 pins and 35 thrums, or a 1:1 ratio. A population of the species in Coffee County, Georgia, sampled by

Hardin (1953) consisted of 22 pins and 18 thrums. To these figures may be added 33 pins and 29 thrums for a population growing in Allendale County, S. C. Both samples probably represent a 1:1 ratio, although the slight excess of one form (if proved valid in larger samples) may be significant in light of Crosby's suggestion (1949) that deviations from 1:1 may result from excessive illegitimate pollinations of one form. The compatibility data for *P. caroliniana* suggest, however, that illegitimate pollinations of pins in the field should be less productive than those involving thrum plants. The information presented above does not establish the genetic basis for distyly in *Piriqueta*, but it does not contradict the possibility that a single pair of supergenes may control its expression, as is true of all other genera which have been studied.

In most features of its breeding system and floral morphology *Piriqueta caroliniana* closely parallels the patterns which have independently evolved in distylous species belonging to other distantly related families, such as the Primulaceae, Polygonaceae, Menyanthaceae, and Rubiaceae. The greater productivity of seeds and capsules from illegitimate pollinations of the thrum flowers than from illegitimate pollinations of the pin flowers is unusual, for in most other families this relationship is reversed (Darwin, 1877).

Little information has been published concerning the breeding systems in the Turneraceae. Lock (*fide* Brizicky, 1961) has reported that the heterostylous *Turnera subulata* J. E. Sm. (as *T. ulmifolia* var. *elegans*) is self-incompatible. Urban observed that homostylous plants of *T. ulmifolia* L. var. *angustifolia* Willd. (var. *ulmifolia fide* Brizicky, 1961) were self-compatible but frequently outcrossed by insects; our own observations on cultivated specimens of this variety confirm these observations. Urban (1883) has pointed out that in various genera of the Turneraceae species pairs exist in which one of the members is heterostylous, large-flowered, and perennial and the other is homostylous, small-flowered, and annual. One of these pairs consists of *Piriqueta caroliniana* and its close relative *P. cistoides* (L.) Griseb., an annual

homostylous species of South America and the West Indies. The breeding system of *P. cistoides* is not known, although by analogy with the behavior of the varieties of *Turnera ulmifolia* described above, and by examples in other genera with closely-related heterostylous and homostylous species (Ernst, 1955; Baker, 1959; Darwin, 1877) it is probably self-compatible. The descriptions of the flowers of various Turneraceae given by Urban (1883) suggest the occurrence of "incomplete" distyly as well as other variations upon the distylous pattern. The family is clearly one which merits further investigation by botanists interested in the comparative evolution of heteromorphic incompatibility systems.

We are grateful to Mr. Harry Ahles for his invaluable assistance in the field, and to Dr. T. B. Mitchell for identifying the bees visiting *Piriqueta*. This research was supported by National Science Foundation grant GB-905.

SUMMARY

Piriqueta caroliniana (Walt.) Urb. var. *caroliniana* is distylous. Its two forms differ from each other in style length, stamen length, and pollen size. Crossing experiments show that the pin (long-styled) and thrum (short-styled) plants are moderately to strongly self-incompatible, but the two forms are highly cross-compatible. In the field, plants are visited by various bees which are effective pollinators. Populations are composed of approximately 1 pin : 1 thrum, suggesting that the genetic basis of distyly in this species may be similar to models proposed for distylous genera of other families. Breeding systems of other Turneraceae are briefly discussed, and a report of self-compatibility in the homostylous *Turnera ulmifolia* L. var. *ulmifolia* is confirmed. *Piriqueta cistoides* (L.) Griseb. is closely related to *P. caroliniana*, but differs in its annual duration and its smaller homostylous flowers; it is probably self-compatible.

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Literature Cited

Baker, H. G. 1954. Dimorphism and incompatibility in the Plumbaginaceae. Rapp. et Comm. 8ème Congr. Int. Bot., sect. 10: 133-134.

———. 1959. The contribution of autecological and genecological studies to our knowledge of the past migrations of plants. Am. Nat. **93**: 255-272.

Brizicky, G. K. 1961. The genera of Turneraceae and Passifloraceae in the southeastern United States. Jour. Arnold Arb. **42**: 204-218.

Crosby, J. L. 1949. Selection of an unfavourable gene-complex. Evolution **3**: 212-230.

Darwin, C. 1877. The different forms of flowers on plants of the same species. London, John Murray. 352 pp.

Ernst, A. 1955. Self-fertility in monomorphic Primulas. Genetica **27**: 391-448.

Hardin, J. W. 1953. Heterostyly in *Piriqueta caroliniana*. Castanea **18**: 103-107.

Hildebrand, F. 1866. Über den Trimorphismus in der Gattung *Oxalis*. Monatsb. Akad. Wiss. Berlin 352-374.

Lewis, D. 1954. Comparative incompatibility in angiosperms and fungi. Advances in Genetics **6**: 235-285.

Mitchell, T. B. 1960. Bees of the eastern United States, vol. I. N. C. Agr. Exp. Sta. Tech. Bull. 141.

Ray, P. M., and H. F. Chisaki. 1957. Studies on *Amsinckia*. I. A synopsis of the genus with a study of heterostyly in it. Am. Jour. Bot. **44**: 529-536.

Thiselton-Dyer, W. T. 1872. Dimorphism in Hypericinae. Jour. Bot. N. S. **1**: 26.

Urban, I. 1883. Monographie der Familie der Turneraceen. Jahrb. Bot. Gart. Berlin **2**: 1-152.

TAXONOMIC FERN NOTES. IV.
SOME AMERICAN VITTARIOID FERNS

ROLLA TRYON

1. THE GENUS POLYTAENIUM

The genera *Antrophyum (sens. str.)*, *Polytaenium* and *Scoliosorus* are all closely related and have been variously united or segregated. Benedict[1] in 1907 treated all of them in the genus *Antrophyum*, a classification that followed most previous authors (*Polytaenium* and *Scoliosorus* being only rarely accepted as valid segregates). This traditional treatment was also followed by C. Christensen[2]. Four years after his first publication, however, Benedict[3] recognized two genera: *Polytaenium* (including *Scoliosorus*) and *Antrophyum*. Copeland[4] in 1947 recognized all three genera. The pertinent characters of these genera are the following:

Antrophyum Kaulf. Enum. Fil. 197. 1824. Type: *A. reticulatum* (Forst.) Kaulf.

Costa absent or extending ca. ½ way toward the apex of the lamina, rarely (in some plants of *A. subfalcatum*) extending ca. ¾ths toward the apex; paraphyses present, with slender, pointed apical cells (*A. alatum*, *A. callifolium*, *A. reticulatum*, etc.) or with enlarged, rounded apical cells (*A. latifolium*, *A. Ledermanii*, *A. subfalcatum*, etc.); spores tetrahedral or (in most African species) bilateral; ca. 30 species in the Old World tropics.

Polytaenium Desv. Mém. Soc. Linn. Paris **6**: 218. 1827. Type: *P. lanceolatum* (Sw.) Desv. = *P. lineatum* (Sw.) J. Sm.

Costa extending to the apex of the lamina, or nearly so; paraphyses absent; spores tetrahedral; 10 species in the American tropics.

Scoliosorus Moore, Ind. Fil. xxix. 1857. Type: *S. ensiformis* (Hook.) Moore.

Costa extending to the apex of the lamina, or nearly so; paraphyses present, with enlarged, rounded apical cells; spores bilateral; 1 species in Mexico and Central America.

The classification of *Scoliosorus* as a separate genus is not satisfactory for it has little, if any, claim to be a monotypic

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[1]BENEDICT, R. C. Bull. Torrey Cl. **34**: 446-447. 1907.
[2]CHRISTENSEN, C. in Verdoorn, Man. Pterid. 539. 1938.
[3]BENEDICT, R. C. Bull. Torrey Cl. **38**: 169, 174. 1911.
[4]COPELAND, E. B. Genera Filicum. 223-225. 1947.

genus since it has no characters that are not found in *Antrophyum* or *Polytaenium*. *Scoliosorus* is closely related to species of *Antrophyum*, some of which have similar paraphyses or spores or only a somewhat less developed costa. Its complete costa is the only character that would place it closer to *Polytaenium*. If two genera are to be recognised, then *Scoliosorus* must be united with *Antrophyum* rather than with *Polytaenium*.

Since the three taxa are all closer to each other than to any related genus, there can be no serious objection to treating them in the single genus *Antrophyum*. This classification, however, has the disadvantage of obscuring their relationship and geography.

The evolutionary relations of the taxa and their geography are presented to the best advantage by the recognition of *Antrophyum* (including *Scoliosorus*) and of *Polytaenium*. *Antrophyum*, then, is a paraphysate genus of the Old World with a single species in Mexico and Central America; and *Polytaenium* is a non-paraphysate American genus. The distribution of *Antrophyum* is a significant one and is similar to other fern genera such as *Coniogramme*, *Loxogramme*, and *Culcita*. *Coniogramme mexicana* (Mexico and Guatemala) is the only American species of a genus represented by about 20 species through the Old World tropics; *Loxogramme mexicana* and *L. Salvinii* (Mexico to Panama) are the American species of a genus of about 35 species in the Old World; and *Culcita coniifolia* (Central America, Hispaniola, Andean South America) is the American representative of a genus of about 8 species in the paleotropics.

There are three species of *Polytaenium* with a broad lamina that are widely distributed in South America. A study of type specimens has revealed that some of the names have been applied incorrectly. The following notes deal with the nomenclature of these species in terms of the present taxonomy although it is evident that this group is in some need of revision. It is worth remarking that Hieronymus (in the herbarium at Berlin-Dahlem) has evidently been the only one to apply the names correctly. His discussion of the

species[5], however did not adequately bring out their characters; and some of the characters he mentions have proved to be of little value.

Polytaenium cajenense (Desv.) Benedict, Bull. Torrey Cl. **38:** 169. 1911.

Hemionitis cajenensis Desv. Ges. Naturf. Freunde Berl. Mag. **5:** 311. 1811, as *cajanensis* on holotype, in Jour. Bot. Appl. **1:** 274. 1813 and in Mém. Soc. Linn. Paris. **6:** 216. 1827. Holotype: French Guiana, Herb. Desv., P! (The collector is not known, but the two leaves of the holotype were doubtless obtained from the collections at Paris, perhaps from that of *Joseph Martin*, French Guiana P!. If this is true, there is an isotype at B! (Herb. Willd. no. 19560). This was marked "type" by Hieronymus but I do not know on what evidence). *Sintenis 6554*, Porto Rico (P) and *Türckheim II 249* in 1913 (P), Guatemala closely match the holotype.

Antrophyum cajenense (Desv.) Spreng. Syst. Veg. **4:** 67. 1827, as *cayennense*.

Antrophyum discoideum Kze. Bot. Zeit. **6:** 702. 1848. Lectotype: Colombia, *Karsten 30*, LZ, destroyed, duplicate B!, photo GH. The other collection cited by Kunze, *Funck & Schlim* (Coll. Fil. *Linden 303*), BM!, P! is *P. brasilianum*. The choice of type is arbitrary.

Antrophyum subsessile var. *elongatum* Mett. Ann. Sci. Nat. V, **2:** 208. 1864, based on *A. discoideum* Kze.

Antrophyum brasilianum var. *elongatum* (Mett.) Hieron. Hedwigia **48:** 247. 1909.

Polytaenium discoideum (Kze.) Benedict, Bull. Torrey Cl. **38:** 169. 1911.

Antrophyum brasilianum and *Polytaenium brasilianum* of most herbaria.

Lamina papyraceous to usually coriaceous, broadly to narrowly oblanceolate, with the apical half broader and more abruptly tapering than the basal half which gradually tapers to the usually strongly alate petiole which is greenish beneath (sometimes drying to light or dark brown) and concolorous or darker than the adjacent leaf-tissue.

Guatemala to Panama; Greater Antilles; Guianas to Venezuela and Colombia, south to Bolivia and Brazil.

Representative specimens: GUATEMALA: *Türckheim II 249* in 1913. COSTA RICA: *Cooper (J. D. Sm. 6019)*. CUBA: *Shafer 8840*. PUERTO RICO: *Sintenis 6554*. VENEZUELA: *Fendler 305*. COLOMBIA: *Karsten 30*. PERU: *Schunke 283, Poeppig 182*.

Desvaux's epithet *cajenense* has usually been applied incorrectly to the common species of the Guianas which is *P. guayanense* (Hieron.) Alston; while the present species

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[5]HIERONYMUS, G. Hedwigia **57:** 213-214. 1915.

has generally been named *P. brasilianum*. A careful examination of the holotype of *Hemionitis cajenensis*, however, leaves no doubt as to its identity. Although there is good evidence that Desvaux preferred (and perhaps intended) the spelling *cajanensis*, I follow the Code in maintaining the spelling as originally published.

Polytaenium brasilianum (Desv.) Benedict, Bull. Torrey Cl. **38**: 169. 1911.

Hemionitis brasiliana Desv. Mém. Soc. Linn. Paris. **6**: 216. 1827. Holotype: Brazil, Herb. Desv. P!, photo GH, US. (The single leaf was probably taken from *Gaudichaud*, Rio de Janeiro, in 1818, P!; it is a close match, except for its more abruptly attenuate apex, for one of the large leaves of *R. S. Williams 1355*, Bolivia).

Hemionitis reticulata var. *brasiliansis* Raddi, Pl. Bras. Nov. Gen. **1**: 8. 1825, probably belongs here. Holotype: Brazil, *Raddi*, presumably at FI.

Antrophyum subsessile Kze. Analect. Pterid. 29. 1837, nom superfl. *(illegit.)* for *Hemionitis brasiliana* Desv.

Antrophyum brasilianum (Desv.) C. Chr. Ind. Fil. 59. 1905.

Antrophyum discoideum and *Polytaenium discoideum* of most herbaria.

Lamina papyraceous, oblanceolate, with the apical half broader and more abruptly tapering than the basal half which gradually tapers to the strongly alate petiole which is more or less straw-colored beneath and lighter than the adjacent leaf-tissue.

Venezuela, Colombia, Bolivia and Brazil.

Representative specimens: VENEZUELA: *Funck & Schlim 303*. BOLIVIA: *R. S. Williams 1355*. BRAZIL: *Martius 369*.

Desvaux's epithet *brasiliana* clearly belongs with this species although it has been commonly applied to the previous one, *P. cajenense*.

Polytaenium guayanense (Hieron.) Alston, Kew Bull. **1932**: 314.

Antrophyum guayanense Hieron. Hedwigia **57**: 212. 1915. Lectotype: Trinidad, *Fendler 151* B!

Antrophyum cajenense and *Polytaenium cajenense* of most herbaria.

Lamina usually papyraceous to rarely coriaceous, narrowly elliptical or with nearly parallel sides, with the apical and basal halves equally broad and tapering (or nearly so), the basal half rather abruptly tapering to the narrowly alate petiole which is more or less straw-colored beneath and lighter than the adjacent leaf-tissue.

Guianas to Trinidad, Colombia, Peru and adjacent Brazil.

Representative specimens: FRENCH GUIANA: *Leprieur 108, Sagot 1119*. TRINIDAD: *Fendler 151*. PERU: *Tryon & Tryon 5300, Spruce 3933*.

Antrophyum Jenmanii Benedict, Bull. Torrey Cl. 34: 454. 1907 (*Polytaenium Jenmanii* (Benedict) Benedict, Bull. Torrey Cl. 38: 169. 1911) is an earlier name than that of Hieronymus and may apply to the same species. It is poorly known and at least in part (*Leprieur 109*, GH, P) it seems to be a variable species and somewhat intermediate between the three species treated here. Until the taxonomy is better understood, I do not feel it wise to alter the taxon or to replace Hieronymus's clearly applied name.

2. THE NAMES OF SOME AMERICAN SPECIES OF VITTARIA.

A study of the type specimens of certain names of *Vittaria* has resulted in additional information about them and their identity. These matters, when they affect the correct name of a species, are presented below.

"Vittaria graminifolia Kaulf. Enum. Fil. 192. 1824.

Holotype: "Brasil, Otto comm.", LZ, destroyed. Lectotype: Brazil, *Sello* B!

Vittaria filifolia Fée, Mém. Fam. Foug 3 (Hist. Vittar.): 20. 1851-52. Lectotype: "Flore de la Guadeloupe, *Herbier L'Herminier, Vittaria filifolia* Fée, hist. des vittar. p. 20," Herb. Cosson, P!

Although the name *Vittaria graminifolia* was earlier used for the species later described as *V. filifolia*, the latter name gradually replaced it. This is probably due to the fact that Fée's description, illustrations and specimen citations made his species and the application of his name quite certain, while the description of Kaulfuss was rather inadequate and the single specimen cited was not readily available for comparison and study. Maxon, for example,[6] cites Kaulfuss' name as a questionable synonym of *V. filifolia*. An investigation of the identity of *V. graminifolia* has led me to the conclusion that it represents the same species as *V. filifolia* and that it must be reinstated as the correct name for that species. Since the holotype of *V. graminifolia* is now lost, some discussion of its probable identity and my reasons for selecting the Sello collection as a lectotype are presented below.

[6] MAXON, W. R. Pteridophyta in Sci. Surv. Porto Rico & Virgin Is. 6: 403. 1926.

Both G. Kunze and G. Mettenius had access to the Kaulfuss herbarium at Leipzig and both of them applied the name *V. graminifolia* to specimens such as *Burchell 2288* and *Linden 168*, among numerous others (B, BM, P) which are the species later called *V. filifolia*. A label in Herb. Mettenius, B, proves that he had studied the holotype of *V. graminifolia*. This label bears the data "V. graminifolia Klf. p. 1688 Brasilia Otto spores tetrahedrico-globose. Paraphyses cellule terminales clavata . . . (word obscure) non punctata" (A later hand wrote "Zeffel ohne Pflanze in Herb. Mett."). Mettenius' usage of the name must then be given some weight. It is also important that the few characters of the holotype indicated (supplementing the original description) are consistent with those of the species in question.

The source of the Brazilian material which Otto sent to Kaulfuss is not known but was possibly a Sello collection. I am designating the specimen at Berlin as a lectotype on the assumption that it is part of the original collection. This action seems preferable to that of choosing a neotype because of the possibility of the existence of an isotype.

The identity of *Vittaria filifolia* is clear. The description, illustrations and specimens cited by Fée all agree with the species as it is currently interpreted. I have seen three of the six collections cited by Fée, *Linden 168*, BM, *Galeotti 6337*, W and *L'Herminier* (several sheets at P), and from these I have chosen one as a lectotype.

Vittaria graminifolia grows in Mexico, through Central America, in the Greater Antilles and in some of the Lesser Antilles, and from Surinam to Venezuela, Colombia and Bolivia, also in Brazil.

The following selected specimens are representative of the species: MEXICO: *Ghiesbreght 255, Hinton 6162, 7369, 14231, 14272, 15496, Purpus 6731.* GUATEMALA: *Tuerckheim 811, 8338, II 541, II 1382.* HISPANIOLA: *Türckheim 2944, Ekman H 7709.* VENEZUELA: *Fendler 258.* COLOMBIA: *Lehmann 5023, H. H. Smith 1057.* BRAZIL: *Burchell 2288.*

Vittaria Moritziana Mett. Ann. Sci. Nat. V, **2**: 207. 1864.
Holotype: Canoas, 2500 m., *Lindig 319* B!

Vittaria Ruiziana sensu Benedict, Bull. Torrey Cl. **41**: 405. 1914.

This species is closely related to *V. stipitata* with which it shares the characters of non-alate, hard and terete or oval petiole. It is separated by the characters of the several-costate rhizome scales and the sporangia that are borne in shallow grooves back from the margin. In *V. stipitata* the rhizome scales are uni-costate and the sporangia are in deep grooves near the margin.

The identity of *Vittaria Moritziana* was correctly interpreted by Benedict *(l.c.)* but he incorrectly applied the earlier name *V. Ruiziana* to the same species.

Costa Rica, Hispaniola, Venezuela to Colombia and south to Bolivia.

The following specimens are representative of the species: COSTA RICA: *Scamman & Holdridge 8112.* HISPANIOLA: *Ekman H 10055, Fuertes 1780.* VENEZUELA: *Fendler 259, Moritz 143, 143b.* COLOMBIA: *Schlim 628, Pennell 9250, Killip & Smith 18770.* ECUADOR: *Mexia 7482.* BOLIVIA: *D'Orbigny 332.*

Vittaria Ruiziana Fée, Mém. Fam. Foug. **3** (Hist. Vittar.): 17. 1851-52.

Holotype Peru, *Ruiz* (not seen). Authentic specimen "Pérou, *Dombey*," B! (photo GH) det. *V. Ruiziana* by Fée. (This specimen "ex Herb. Mus. Paris" is doubtless a part of "Pteris lineata L. Huasi-Huasi, *Dombey*, in 1779" P).

Pteropsis vittarioides Desv. Mém. Soc. Linn. Paris **6**: 219. 1827. Holotype: Peru, Herb. Desv., P! (The single leaf was undoubtedly taken from "Pteris lineata L. Huasi-Huasi, *Dombey*, in 1779," P; a duplicate with the same data but the year omitted and "Vittaria lancea Desv." added is at B! (Hb. Kunth), photo GH.

Vittaria Orbignyana Mett. ex Kuhn, Linnaea **36**: 66. 1869. Holotype: Yungas, Bolivia, *D'Orbigny 229* B! (photo GH). Isotype: GH! P! (a much better specimen).

Vittaria vittarioides (Desv.) Weath. Contrib. Gray Herb. **114**: 34. 1936, not (Thouars) C. Chr. Ind. Fil. 655. 1907.

Although Benedict (l.c.) used the name *V. Ruiziana*, he applied it to another species *(V. Moritziana)* and did not include the present species in his treatment. *Vittaria Ruiziana* is related to *V. remota*, *V. Gardneriana* and *V. latifolia*

in its narrowly alate, flattened and soft petiole. It differs from the first two in lacking a costal ridge at the base of the linear lamina, and from the last one by the shape of the lamina and the characters of the rhizome scales.

I have not seen the Ruiz collection cited by Fée in several of the herbaria that might have it; an isotype may be sought especially at MA or FI. The specimen at B annotated by Fée agrees with the original description and illustration and it may properly be taken to represent the name until an isotype is found.

Vittaria Ruiziana is evidently a rather rare species of the Andes from Venezuela to Bolivia.

Representative specimens: VENEZUELA: *Jahn 918* (in part). COLOMBIA: *Pennell & Killip 6488, 7354.* ECUADOR: *Jameson 20* (in part). PERU: *Vargas 1588, 11157, Macbride 4136.* BOLIVIA: *Steinbach 6173, D'Orbigny 229.*

GRAY HERBARIUM, HARVARD UNIVERSITY.

PLANTAE COLOMBIANAE, XVII
PHILODENDRA EX REGIONE AMAZONIAE NOVA

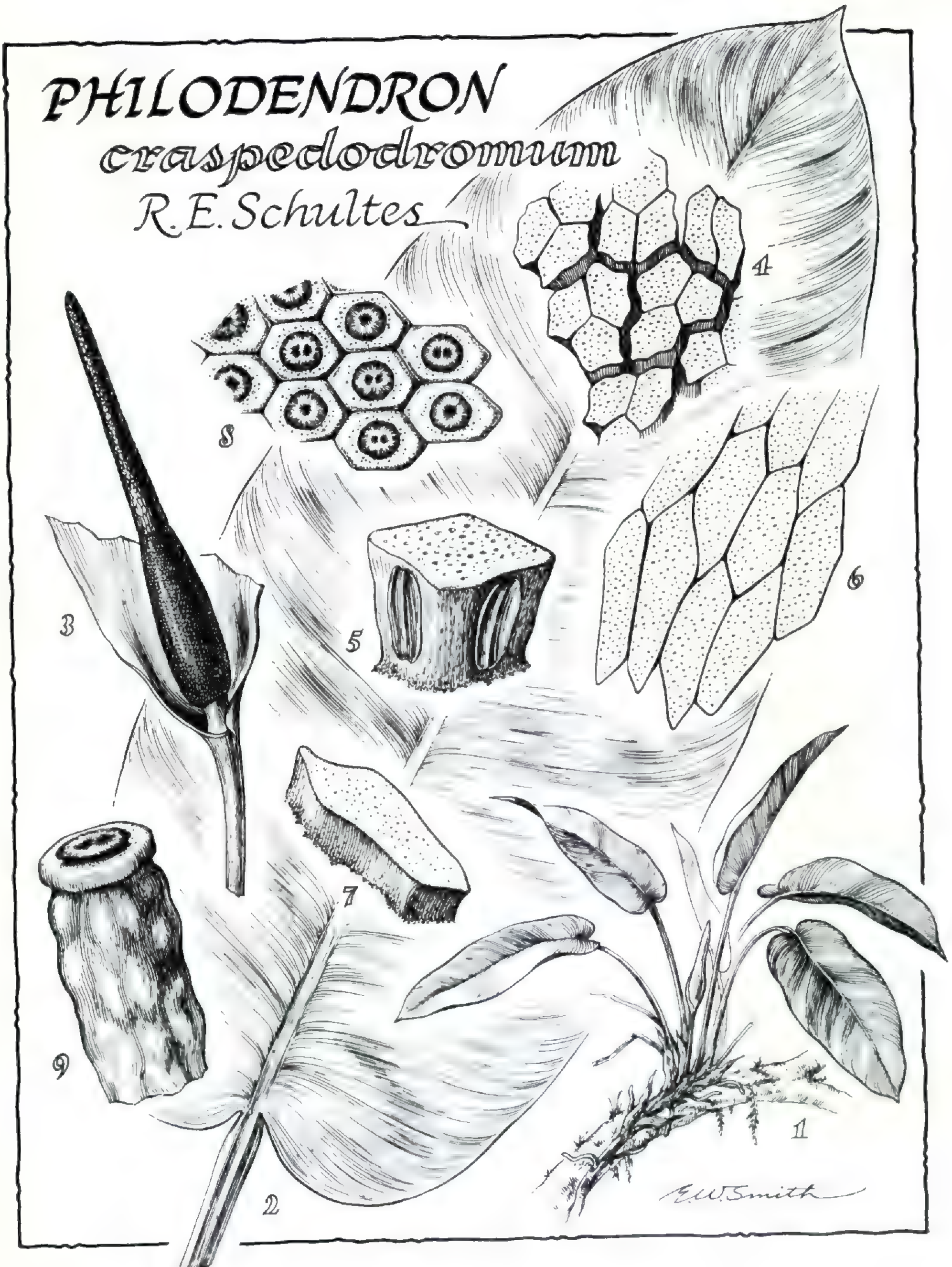
RICHARD EVANS SCHULTES

Three interesting and extremely beautiful species of *Philodendron* from the Amazonian regions of Colombia, all apparently rather closely allied, have been found to be hitherto undescribed. There is no question in my mind but that the family Araceae in northwestern Amazonia is still, mainly as a result of inadequate collecting, very poorly studied and offers the botanist a wealth of species and varieties as yet unknown to science. The opportunities for discoveries of this sort seem to be better in the genus *Philodendron* than in most others, because of the diversity of species in this part of South America. A number of the species have interesting folk uses.

This study, part of an investigation of the phytogeography of the northwestern Amazon, has been supported in part by a grant from the National Science Foundation. The illustrations reproduced in the present paper have been made possible through this grant.

1. **Philodendron craspedodromum** R. E. Schultes, sp. nov.

Planta epiphytica, subvolubilis. Caudex crassus. Foliorum confertorum petiolus crassus, conspicue sulcatus, medio usque ad 45 cm. longus, 13 mm. diametriens. Lamina valde coriacea, supra nitidissima, subtus pallide viridis, lanceolato-elliptica, basi conspicue cordata, apice breviter acuminata, nervo centrale crasso, siccitate striato, basi plus minusve 1 cm. in diametro, nervis lateralibus plerumque aequalibus parallelibus, numerosissimis sub angulo plerumque obtuso e costa inferne latiuscula sursum evanescente prodeuntibus marginem versus leviter arcuatim adscendentibus percursa. Pedunculus spatha subaequalis, teres sed apicem versus incrassatus, viridis, plus minusve 12 cm. longus, 5-6 mm. diametriens. Spatha extus viridis, plus minusve 14 cm. longa. Spadix stipitatus (1 cm.), spatha subaequalis usque ad 12 cm. longus; inflorescentia feminea 4.5 cm. longa, basi incrassata et 1.7 cm. diametriens; mascula 5-5.5 cm. longa, plus minusve 6 mm. diametriens; masculae pars sterilis 1-1.4 cm. longa. Pistillum late columnare, apice valde truncatum, non-angulatum, plus minusve 3 mm. longum, 1.5 mm. in diametro, stigmate subcirculare piloso et corona carnosa armato; flores masculi diandri, staminodia truncata, irregulariter elongato-rhombica, plerumque 0.5 mm. longa, 0.3 × 0.8 mm. lata; stamina quam



Figs. 1-9, *Philodendron craspedodromum* R. E. Schultes. 1, Habit, × about 1/16. 2, Leaf, × about 2/5. 3, Inflorescence, slightly less than 1/2 natural size. 4, Portion of surface of distal part of spadix, showing stamens loosely grouped in threes, vaguely defining the staminate flowers, × about 10. 5, stamen, lateral view, × 25. 6, Portion of surface of sterile part of spadix, showing staminodes, × 10. 7, Staminode, lateral view, × about 10. 8, Portion of surface of basal part of spadix, showing pistillate flowers, × about 7 1/2. 9, Young fruit, × 10. Drawn by E. W. Smith.

staminodia valde inaequalia, apice valde truncata, 0.5 mm. longa, in circuitu quadrata, 0.5×0.5 mm. diametriens, antheris plus minusve 0.4 mm. longis.

COLOMBIA: Comisaría del Vaupés, Río Apaporis, Raudal Yayacopi (La Playa) and vicinity. Quartzite base. Altitude about 800 ft. "Climbing and hanging. Spathe unopened: green outside. Epiphyte." February 15, 1952, *Richard Evans Schultes et Isidoro Cabrera 15347* (TYPE: US, Nos. 2167049, 2167050).

This species, *Philodendron craspedodromum*, appears to be closely related to *P. remifolium*, belonging to Section *Baursia* of subgenus *Philodendron*. The differences which separate the two are small but numerous, and the two have a somewhat different aspect in their natural habitat. *Philodendron craspedodromum* grows epiphytically (climbing or hanging) on tree-trunks in light forest on a quartzitic base, whereas *P. remifolium* is a terrestrial (caespitose) species found on granitic sands. In the former, the zone of pistillate flowers occupies a much larger area (nearly half the spadix) than in the latter (where it measures about one-quarter of the spadix); the staminate flowers, though vaguely defined, tend to occur in two or three parts, rather than in four; the staminodes are larger and more elongated than in *P. remifolium*. The leaves of *Philodendron craspedodromum* tend to be narrower and more cordate than those of *P. remifolium*. A conspicuous difference between *Philodendron craspedodromum* and *P. haematinum* and *P. remifolium* is the complete homogeneity of all of the very numerous, parallel and unbranched lateral nerves (whence the specific name *craspedodromum*) in the former, whereas the latter species have some of the lateral nerves heavier than the rest.

The leaves and petioles of *Philodendron craspedodromum* are reputed by the Desano Indians of the Río Papurí to be toxic to fish when crushed and cast into stagnant waters. When used for fish-poisoning, the leaves are cut, tied into small bundles and set on the forest floor for one or two days to "steam" and start fermentation and rotting before being crushed for use.

2. **Philodendron haematinum** R. E. Schultes, sp. nov.

Caudex crassus brevissimusque. Foliorum confertorum erectorum petiolus tumescens crassus, semiteres, basi subpurpurescens, breviter

Figs. 1-10, *Philodendron haematinum* R. E. Schultes. 1, Habit, × about 1/20. 2, Leaf, × about 3/16. 3, Inflorescence, slightly less than 1/2 natural size. 4, Portion of surface of basal part of spadix, showing pistillate flowers, × about 5. 5, Young fruit, × about 6. 6, Ovule or young seed, × about 20. 7, Portion of surface of distal part of spadix, showing stamens from above, × about 5. 8, Stamen, lateral view, × about 10. 9, Portion of surface of sterile part of spadix, showing staminodes, × about 5. 10, Staminode, lateral view, × about 15. Drawn by E. W. Smith.

vaginatus, 10-15 cm. longus, 2-2.3 cm. in diametro. Folia atroviridia, supra nitidula, crassiuscula, coriacea, erecto sed medio arcuate nutantia, lamina oblanceolata, apice acuta, basi rotundata, 75-90 cm. vel ultra longa, plus minusve 25 cm. lata, nervo centrale crassissimo-cartilagineo, basi usque ad 1.3 cm. diametriens, lateralibus numerosissimis, densissimis, omnibus subaequalibus angulo circiter 50° a costa modice valida abeuntibus marginem versus subarcuatim adscendentibus percursa. Pedunculi longi, teretes, crassissimi, valde purpurei vel atrosanguinei, usualiter angulo 45° a caudice abeuntes sed saepissime leviter arcuati, usque ad (vivo) 1.5 cm. in diametro, 25 cm. longi, ad spadicem valde inglati. Spatha crassa, extus vinicolor sed intus sanguinea, oblonga, apice rotundata, 15 cm. longa, plus minusve 6 cm. lata, tubo elongato-ovoideo, medio leviter constricto, basi 5-5.5 cm. in diametro, usque ad 16 cm. longo. Spadix albus, maturitate subflavescens vel brunneus, apice obtusus, non stipitatus, 11-15 cm. longus; inflorescentia feminea masculam subaequans, 6 cm. longa, maturitate 2-2.3 cm. in diametro, mascula 7.5 cm. longa, 1.6 cm. in diametro, inflorescentiae masculae pars sterilis brevissima, 0.6 cm. longa, et 1.2 cm. in diametro. Pistillum late columnare, apice valde truncatum, angulatum, conspicue tuberculosum, plus minusve 3 mm. longum, stigmate plus minusve hexagonale piloso coronatum; flores masculi 2- vel 4-andri, stamina plus minusve 2.2 mm. longa; anthera circiter 1.6 mm. longa; staminodium subcolumnare, truncatum, apice valde serrato-laciniatum, angulatum, circiter 1.2 mm. longum, 1 mm. diametriens.

COLOMBIA: Comisaría del Amazonas, Río Caquetá, La Pedrera and vicinity. "Epiphyte. Spathe deep wine-coloured, red inside. Spadix whitish." October 12, 1952. *Richard Evans Schultes et Isidoro Cabrera 17804*. (TYPE: ECON). Comisaría del Vaupés, Río Apaporis, Soratama (above mouth of Río Kananarí) and vicinity. Alt. about 900 ft. "Epiphyte. Peduncle and spathe purplish." March 26, 1952. *R. E. Schultes et I. Cabrera 16067*. Comisaría del Vaupés, Río Kuduyarí, Yapobodá (Quartzite savannah near headwaters). "In trees. Spadix pure white. Spathe scarlet within, maroon without. Stalk maroon." August 16, 1960. *R. E. Schultes 22678*.

This species, *Philodendron haematinum*, so named because of the excessive amounts in the spathe of red sap which stains anything with which it comes in contact, appears to be related to *P. dyscarpium* R. E. Schult., *P. remifolium* and *P. craspedodromum*. It belongs to Section *Baursia* of subgenus *Philodendron*, but it is distinct from other members of this group on a number of points. Principal of these distinguishing characters are the curiously arching inflorescence and certain floral structures, such as the very short staminodes which are crowned with a serrate-lacinate membranous ring.

Plate 1294. *Philodendron haematinum* R. E. Schultes. Photograph of the plant from which the collection *Schultes 22678* from the Vaupés of Colombia was made. Photograph by R. E. Schultes.

The red colouring matter in the spathe has magical significance to witch-doctors of the Kubeo Indians living along the Río Kuduyarí. Although I was unable to ascertain its real significance, I have on several occasions seen witch-doctors, by handling these spathes, dye their hands red before "theating" a patient.

3. **Philodendron remifolium** R. E. Schultes, sp. nov.

Planta terrestris, arenicola, caespitosa, subacaulis caudice abbreviato. Caudex brevis, crassus. Foliorum confertorum petiolus crassus, subteres sed leviter sulcatus, usque ad 45 cm. longus, medio usque ad 1 cm. in diametro. Lamina valde coriacea, supra nitida, subtus pallide viridis, elliptica vel conspicue remiformis, rotundata sed apice ipso brevissime apiculata, basi rotundata vel subcordata, plus minusve 35 cm. longa, 21 cm. lata, nervo centrale crasso, siccitate striato, basi 1 cm. diametriens, nervis lateralibus primariis plus minusve vigintiquinque parallelibus, secundariis numerosissimis, densissimis, subaequalibus sub angulo plerumque obtuso e costa inferne latiuscula sursum evanescente prodeuntibus marginem versus leviter arcuatim adscendentibus percursa. Pedunculus quam spatha paulo longior, teres, sanguineo-viridis, 15 cm. longus, 0.5 cm. diametriens, apicem versus incrassatus. Spatha extus albo-viridis, basim versus rufo-viridis, intus flavescens vel rufo-flava, plus minusve 13.5 cm. longa, 3.5 cm. lata. Spadix cylindricus, stipitatus (1 cm.) spatham subaequans usque ad 15 cm. longus; inflorescentia feminea brevissima, 2.5 cm. longa, 1.5 in diametro, mascula 7 cm. longa, plus minusve 1 cm. in diametro, masculae pars sterilis brevis, plus minusve 1.5 cm. longa, 1.3 cm. in diametro. Pistillum late columnare, apice valde truncatum, angulatum, plus minusve 1.8 cm. longum, 0.8 mm. in diametro, stigmate hexagonale piloso et corona carnosa armato; flores masculi 2-andri, staminodia truncata plus minusve 1.5 mm. longa, 1.5 mm. in diametro; stamina quam staminodia aequalia, antheris 1.3 mm. longis, apice valde truncata et indurata.

Colombia: Comisaría del Vaupés, Río Paca (tributary of Río Papurí), Wacaricuara and vicinity. Alt. about 650 ft. Lat. 0°30′ N, Long. 70°10′W. June 1-3, 1953, *Richard Evans Schultes et Isidoro Cabrera 19553* (Type: econ).

Known in the Tukano language as *bĕ-kĕ-ta-po*, *Philodendron remifolium* appears to differ from other species of the western Amazon in its conspicuous paddle-shaped leaf — whence the specific epithet. Its very distinctive caespitose habit likewise is not seen commonly in Amazonian species of the genus.

Belonging to subgenus *Philodendron*, Section *Baursia*,

Figs. 1-11, *Philodendron remifolium* R. E. Schultes. 1, Habit, × about 1/16. 2, Leaf, slightly less than 1/2 natural size. 3, Inflorescence, × about 1/2. 4, Spadix and partly dissected spathe, × about 1/2. 5, Portion of surface of distal part of spadix, showing vaguely distinct staminate flowers, × about 3. 6, Stamen, lateral view, × about 10. 7, Portion of sterile part of spadix, showing staminodes, × about 3. 8, Staminode, lateral view, × about 10. 9, Pistil, lateral view, × about 15. 10, Portion of surface of basal part of spadix, showing pistillate flowers, × about 7 1/2. 11, Ovule, × about 60. Drawn by E. W. Smith.

this new species appears to be most closely allied to *Philodendron dyscarpium* and *P. haematinum*. From both species, it can readily be distinguished by differences in leaf shape and in habit of growth. The structure of the pistil (especially of the pilose stigma elevated on a carnose crown), the stamen and the staminodia is very appreciably distinct in the three species. There are, likewise, differences in colour of the spathe and spadix.

The coarsely leathery leaves of *Philodendron remifolium* are dried, chopped into small pieces and added to fermenting chicha made from various fruits for Tukanoan festivals. The aroid leaves are said to impart an acidic flavour to the beverage.

BOTANICAL MUSEUM OF HARVARD UNIVERSITY,
CAMBRIDGE, MASSACHUSETTS

THE GENUS SUBULARIA (CRUCIFERAE)[1]

GERALD A. MULLIGAN AND JAMES A. CALDER

INTRODUCTION

While preparing a flora of the Queen Charlotte Islands, Calder noted that North American plants of *Subularia aquatica* differed from those of Europe and Asia in the shape of the silicles. Subsequent studies by both authors revealed additional morphological characters by which the Old and New World populations can be separated. Although these morphological differences are usually sharp, some nearly intermediate plants occur in western North America. We are recognizing the two populations at subspecific rank, the Old World as ssp. *aquatica* and those of the New World as ssp. *americana*.

There are only two species in the genus *Subularia*, the North American-Eurasiatic *S. aquatica* L. and a plant of high elevations in central Africa, *S. monticola* A. Br. Both species have grass-like leaves, an unusual type of leaf morphology for the family Cruciferae. Plants with similar leaves are frequently found growing in association with both species of *Subularia* throughout their ranges. *Subularia aquatica* is usually associated with *Eleocharis acicularis* (L.) R. & S. and superficially similar species of *Limosella*. In Africa, *S. monticola* occurs with *Limosella africana* Glück and *Scirpus setaceus* L. We suspect that there is some adaptive value for the aquatic *Subularia* in having grass-like leaves.

Hedberg (1957) reports chromosome counts of 2n = 28 on material of *S. monticola* from Mt. Kenya *(Hedberg 1727, 1804)*. Löve and Löve (1956) reported ca. 36 for material of *S. aquatica* ssp. *aquatica* from Iceland. Observations on plants grown from seed of *S. aquatica* ssp. *americana* from Quebec *(Lepage 33, 378)* showed the chromosome number to be approximately $2n = 28$. Obviously more chromosome

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[1]Contribution No. 336 from Plant Research Institute, Canada, Department of Agriculture, Ottawa, Ontario.

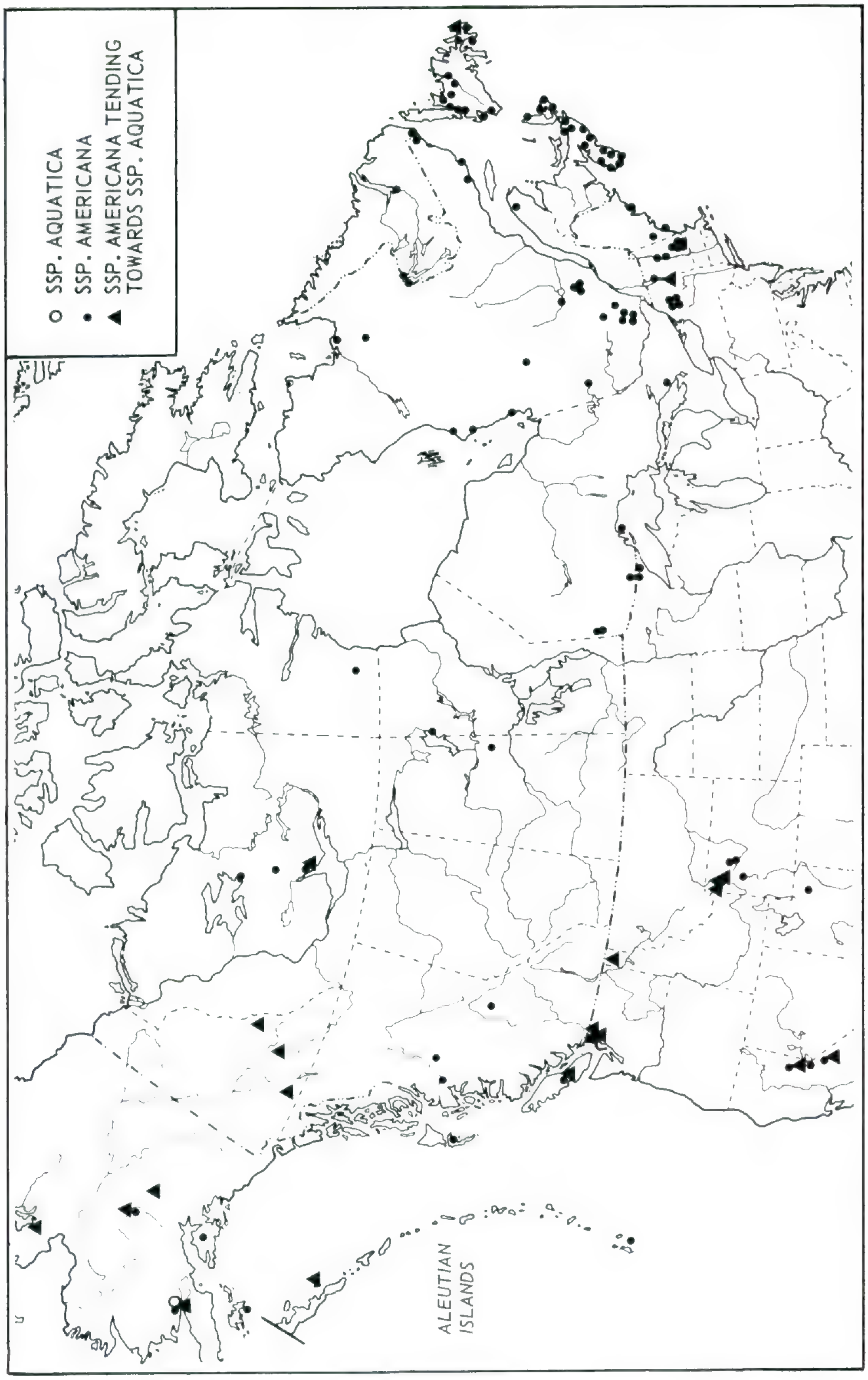

Fig. 1. Distribution of *Subularia aquatica* in North America.

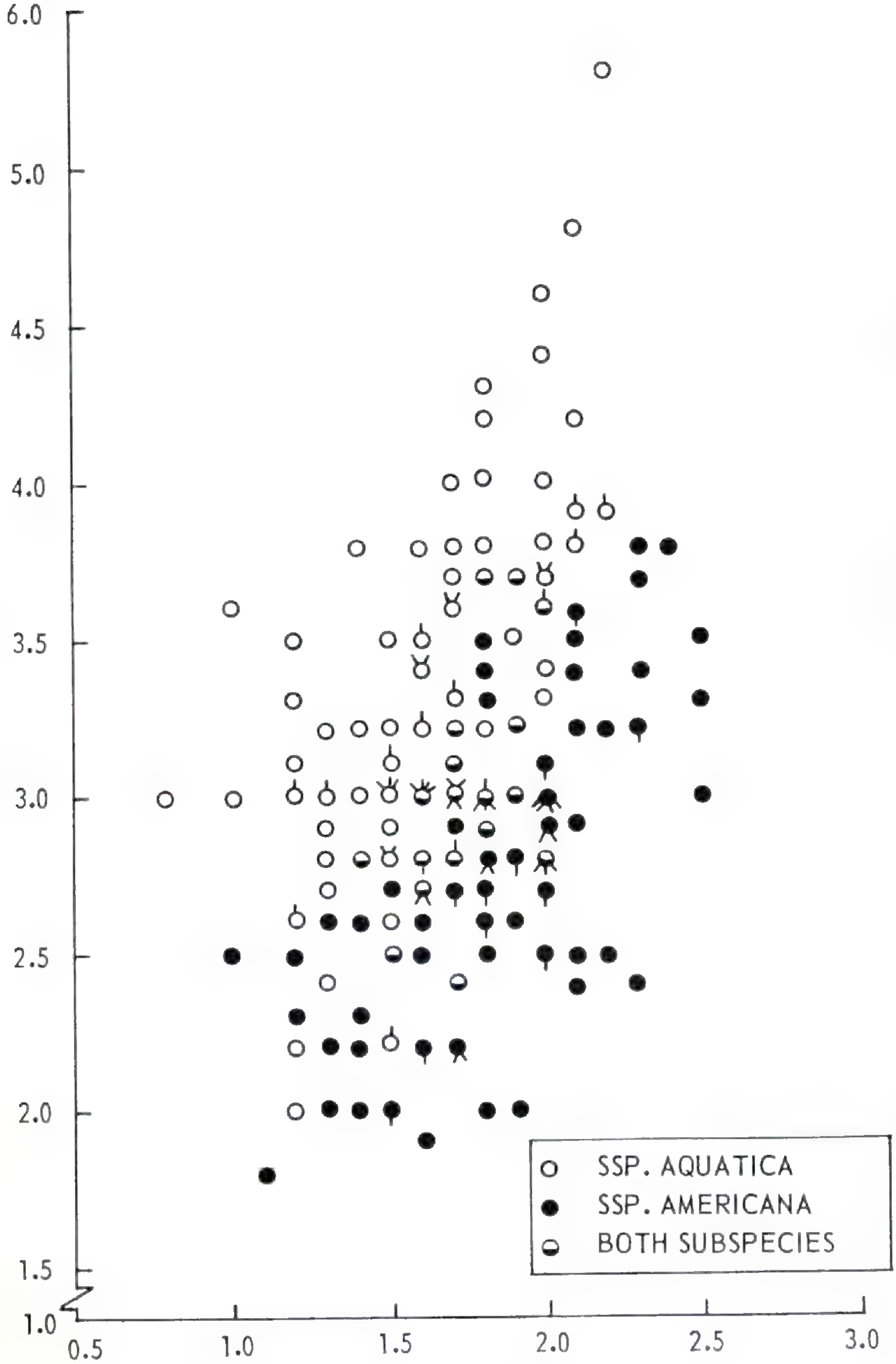

Fig. 2. Scatter diagram comparing width-length ratio of silicles of ssp. *aquatica* and ssp. *americana*. Each arm represents an additional measurement.

determinations are needed for both subspecies of *S. aquatica*.

We would like to express our appreciation to the curators of the following herbaria for the loan of specimens: British Museum of Natural History, London (BM); National Museum of Canada, Ottawa (CAN); Gray Herbarium of Harvard University, Cambridge (GH); Komarov Botanical Institute of the Academy of Sciences, Leningrad (LE); University of New Hampshire, Durham (NHA); New York Botanical Garden, New York (NY); Naturhistoriska Riksmuseum, Stockholm (S); University of California, Berkeley (UC). We also wish to thank Drs. J. H. Soper and M. Raymond for kindly furnishing us with a number of records for Ontario and Quebec.

TAXONOMY

Subularia L., Sp. Pl. 642. 1753. Dwarf, glabrous, aquatic or littoral annuals, usually 2.0-10.0 (-23.0) cm. high; leaves entire, narrowly subulate to linear, 1.0-5.0 (-7.5) cm. long; scape leafless, inflorescence an open to congested raceme, 2-12 (-18)-flowered; sepals 0.7-1.3 mm. long; petals white, slightly exceeding the sepals; stigma entire, sessile; stamens 6; silicles inflated, dehiscent, up to 5.0 mm. long and 2.5 mm. broad, narrowly elliptic to broadly obovate on divaricate to strongly ascending pedicels; seeds light brown, usually up to 6 in each locule, about 1.0 mm. long; flowers apparently self-pollinated and when submerged cleistogamous.

Key to the genus Subularia

Leaves narrowly subulate; stem below lowest pedicel less than 0.5 mm. thick; stem between adjacent pedicels longer than the pedicels. ..... 1. *S. aquatica.*

Sepals caducous; mature silicles narrowly elliptic to elliptic, rarely broadly elliptic or broadly obovate; lowest pedicel axil frequently 50°-90°. ..... 1a. ssp. *aquatica.*

Sepals usually persisting at base of silicles; mature silicles elliptic to broadly obovate, rarely elliptic; lowest pedicel axil frequently 30°-50°. ..... 1b. ssp. *americana.*

Leaves essentially linear, tapering above the middle; stem below lowest pedicel more than 0.5 mm. thick; stem between adjacent pedicels shorter than the pedicels. ..... 2. *S. monticola.*

1. *Subularia aquatica* L.

1a. *Subularia aquatica* L. ssp. *aquatica*, Sp. Pl. 642, 1753. Savage Catalogue (1945) No. 822.1, Linnaean Herbarium, London (LINN; photograph, DAO!).

General distribution. Widely distributed in northern Europe, including Iceland and the Faroe Islands and extending eastward to the Urals. Disjunct to Kamtschatka and Naknek, Alaska. It is of sporadic occurrence in south-central Europe (see distribution map 197, Hultén, 1958).

Almost all plants from the Old World lack sepals at the base of the mature silicles and this single character is sufficient to segregate almost all European plants from those in North America. In addition, the silicles of Eurasiatic plants are usually narrowly elliptic while those from North America are usually broadly obovate.

We have examined over 200 herbarium specimens of ssp. *aquatica*. Included were specimens from all the disjunct areas indicated in Hultén's excellent distribution map of the species. The few Old World collections that differed slightly from most European and Asiatic plants were usually collected at the periphery of its range or in the disjunct areas. One of three collections made by Hartz and Osterfeld in the Faroe Islands in 1897 had plants with nearly subglobose silicles. Two other collections from the Pyrenees in southeastern France and northeastern Spain had atypical fruits. Only one Old World collection might have been included in ssp. *americana:* Plantae Finlandiae Exsiccatae (University of Helsingfors) 688, Lapponia Kemensis, Kuolajarvic, Aug. 23, 1910, *Hällstrom* (NY, S, UC). This plant, labelled f. *elongata*, is a close match for a number of atypical specimens of ssp. *americana* from western North America. Almost all other specimens were easily distinguished as ssp. *aquatica*. These included specimens from Bulgaria, and from the Altai, Lake Baikal and Kamtschatka in the U. S. S. R.

The only indication we have that ssp. *aquatica* occurs in North America is a collection from the head of Bristol Bay on the west coast of Alaska: Naknek, July 28, 1946, *Norberg* (UC). Some of the plants of this collection are clearly ssp.

aquatica while others are intermediate between the two subspecies. We also saw typical ssp. *americana* from Naknek.

1b. *Subularia aquatica* L. ssp. **americana** ssp. nov.

A ssp. *aquatica* differt: sepalis saepe perseverantibus; siliculis ellipticis vel late obovatis, raro anguste ellipticis; axilis pedicellorum infimorum saepe ad 30°-50°.

Type: Big Mushamush Lake, Nova Scotia, *Fernald & Long 457*, [Plantae Exsiccatae Grayanae] (DAO; isotypes CAN, GH, LE, NY, S, UC).

General distribution. Greenland to Aleutian Islands, south to New Hampshire in eastern North America and at high elevations to California and Utah in the west (Fig. 1).

Selected citations: GREENLAND: Tasersuak, Tasermiut Fjord, Sept. 1, 1889, *Hartz* (BM, LE). KEEWATIN DISTRICT: lake on Tha-anne River, *Porsild 6176* (CAN, GH, S). MACKENZIE DISTRICT: McTavish Arm, Great Bear Lake, *A. E. & R. T. Porsild 3696* (CAN, GH, S); Yellowknife, *Cody & Gutteridge 7316* (BM, DAO, NY). ALASKA: Attu Island, Aug. 29, 1891, *Macoun* (CAN, GH, NY, S); Three Saints Bay, Kodiak Island, *Eyerdam 558* (BM, NY, S); Snow River Delta, Kenai Peninsula, *Calder 6586* (DAO, NY, UC); Naknek, *Schofield 2707* (DAO). LABRADOR: Hamilton River, *Gillett & Findlay 5911* (DAO); Blanc Sablon River, *Fernald & Wiegand 3472* (GH, NY); Knob Lake area, *Hustich 576 & 717* (CAN). NEWFOUNDLAND: Tomkins, *Roland & Smith 123* (DAO); Grand Falls, *Fernald et al. 5470* (CAN, GH, NY, UC); Badger Brook, Exploits River, *Robinson & Schrenk 7* (CAN, GH, LE, NY); Birchy Cove, Bay of Islands, *Fernald et al. 3473* (GH, NY). NOVA SCOTIA: Twin Lake, Digby Co., *Fernald & Long 23874* (CAN, GH, LE, NY); Banook Lake, Halifax Co., *Dore et al. 45.1099* (DAO); Warren Lake, Victoria Co., *Smith et al. 5614* (DAO); Salmon Lake, Yarmouth Co., *Fernald et al. 21290* (BM, CAN, GH, NY). QUEBEC: Great Whale River, *Savile 708* (DAO); Fort Chimo, *Calder 2672* (DAO); Lac Grelon, Parc National des Laurentides, *Dansereau & Desmarais 3231* (DAO, S); Lac Monroe, Parc du Mont Tremblant, *Rolland-Germain 71* (CAN, DAO, S, UC); Lac Fortin, Gaspé Co., *Fernald & Collins 590* (CAN, GH). ONTARIO: Eagle Lake, Kenora District, Sept. 13, 1882, *Fletcher* (DAO); Port Sandfield, Lake Muskoka, Sept. 1, 1889, *Britton et al.* (NY); St. Ignace Island, Thunder Bay District, *Garton 6589* (DAO, TRT). MANITOBA: Reindeer Lake, *Baldwin 2439* (CAN, GH). SASKATCHEWAN: Amisk Lake, *Hudson 1401* (DAO). BRITISH COLUMBIA: Lake Kathlyn, Smithers, *Calder et al. 15242* (DAO, UC); Wells, *Taylor 9043* (UBC); Mosquito Lake, Queen Charlotte Islands, *Calder & Taylor 23653* (DAO); Sproat Lake, Vancouver Island, Aug. 12, 1887, *Macoun* (CAN, LE, NY). MAINE: Belgrade Lakes, Kennebec Co., *Gager & Svenson 6360* (GH, UC); Mount Desert Island, Aug. 7, 1906, *Rand* (UC). NEW HAMPSHIRE: Echo Lake, Franconia, Oct. 1, 1887, *Faxon* (GH, LE, NY); Gilmanton, Sept. 24, 1864, *Blake* (GH, NY); Mirror Lake, Tuftonborough, *Pease 19224* (GH); Strafford, Strafford

Co., *Hodgdon et al. 0395* (NHA). VERMONT: South Pond, Marlboro, Sept. 15, 1895, *Grout & Eggleston* (GH, NY). NEW YORK: Piseco Lake, Hamilton Co., *Muenscher & Lindsey 3348* (GH, UC); Long Lake, Hamilton Co., *Muenscher & Clausen 3906* (GH, UC). MINNESOTA: Snow Bank Lake, Lake Co., *Lakela & Elwell 22420* (GH); Basswood Lake, Lake Co., *Lakela 18497* (DAO). WYOMING: New Fork Lakes, Sublette Co., *Payson & Payson 4681* (GH). UTAH: Mirror Lake, Duchesne Co., *Maguire et al. 4340* (GH, UC). CALIFORNIA: Summit Valley, Sept. 20, 1882, *Pringle* (GH, LE, NY); Weber Lake, Sept. 6, 1886, *Lemmon* (GH); Lake Tahoe, [?*Lemmon*] (UC).

The following collections of ssp. *americana* tend towards ssp. *aquatica:* YUKON: Mile 222 Canol Road, *Porsild & Breitung 11503* (CAN, S); Whitehorse, Sept. 1, 1902, *Macoun* (CAN, S). ALASKA: Sanak Island, *Steenis 4765* (S); Naknek, *Schofield 2644* (DAO, NY, S); Wonder Lake, Mt. McKinley National Park, *Viereck 1671* (S, UC). NEWFOUNDLAND: Whitebourne, *Fernald et al. 26719* (GH). BRITISH COLUMBIA: Somas River near Alberni, *Calder & MacKay 32136* (DAO). NEW YORK: Lake George, Washington Co., *House 28318* (GH). WYOMING: Dinwoody Creek, Fremont Co., *Porter 6207* (DAO, GH, UC); Yellowstone Lake, *Parry 27* (GH, LE, NY). IDAHO: Priest Lake, *Piper 3766* (GH, NY, UC). WASHINGTON: Whatcom Lake, Whatcom Co., *Suksdorf 1936* (GH); Baker Lake, Whatcom Co., *Muenscher 7912* (GH). CALIFORNIA: Donner Lake, Sept. 1888, *Brandegee* (UC).

North American specimens of *S. aquatica* collected east of the western boundary of the Precambrian Shield are uniformly quite distinct from European plants of this species. They have extremely persistent sepals, broadly elliptic or broadly obovate silicles and the lowest pedicel axils are from 30° to 50°. There is a distinct gap between this uniform eastern population and a heterogeneous one in the Cordilleran Region of western North America where about half the specimens examined were slightly atypical. The majority of these atypical plants have only a few sepals adhering to the mature silicles and a small proportion entirely lack sepals but do have broadly elliptic or broadly obovate silicles.

The lengths and widths of 100 silicles of both ssp. *aquatica* and ssp. *americana* were plotted in figure 2. The scatter diagram clearly shows a distinct difference between the Old and New World populations in the length to width ratios of the silicles. The range in variation of silicles of both subspecies of *S. aquatica* and also *S. monticola* are shown in Plate 1295.

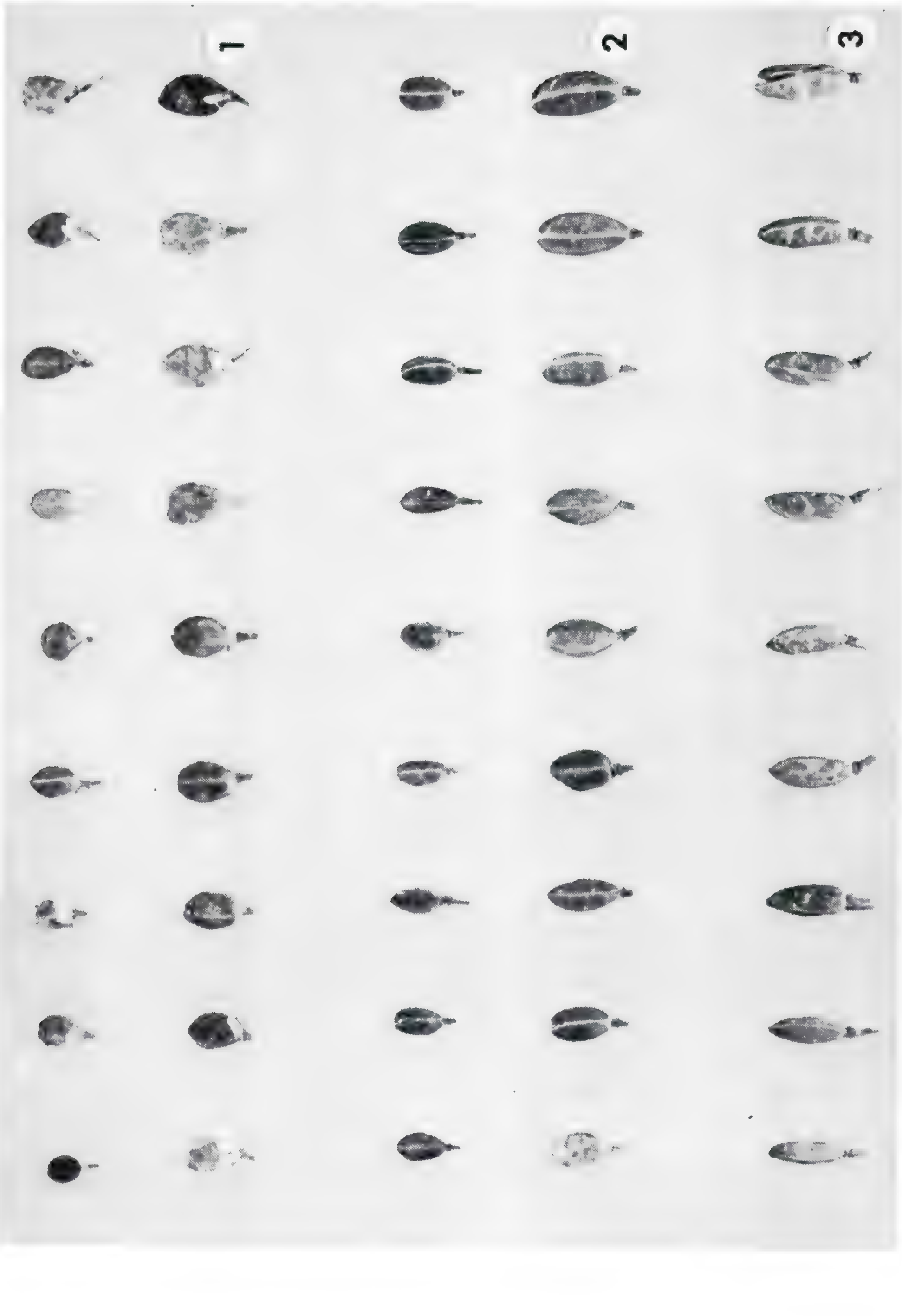

Plate 1295, Figs. 1-3. Silicles of *Subularia, aquatica* ssp. *americana*. Fig. 1. *S. aquatica* ssp. *aquatica*. Fig. 2. *S. aquatica* ssp. *aquatica*. Fig. 3. *S. monticola*. × 2.

2. *Subularia monticola* A. Br. ex Schweinf., Beitr. Fl. Aethiop. 76: 1867.

Isotype: Mt. Dedschen, 1400′ 7 Oct. 50 [1850] (S! photograph DAO!).

General distribution. At high elevations on the African mountains of Uganda, Congo, Kenya, and Tanganyika (see Hedberg 1957).

CANADA DEPARTMENT OF AGRICULTURE
OTTAWA, ONTARIO

Literature Cited

Hedburg, O. 1957. Afroalpine Vascular Plants. Symb. Bot. Upsal. XV: 1. 1-411, pl. 1-12.

Hultén, E. 1958. The Amphi-Atlantic Plants. Vet. Akad. Handl. Ser. 4, Bd. 7, No. 1: 1-340.

Löve, A. and D. Löve. 1956. Cytotaxonomical conspectus of the Icelandic flora. Acta Horti Gotoburg. **20**: 65-291.

Note on Cimicifuga rubifolia Kearney in Virginia[1]

Cimicifuga rubifolia Kearney, known from eastern Tennessee and southern Illinois (as *C. racemosa* var. *cordifolia*) but not previously recorded as growing in Virginia, has been found well established in two locations in Scott County. It was found on the Clinch River between the Tennessee-Virginia state line and Highway 23 near Clinchport on June 22, 1963 (No. *495* and *496*), and on the north fork of the Holston River, east of Highway 23, between Kingsport, Tennessee, and Gate City, Virginia, on August 10, 1963 (No. *511*). In both areas it grows on north-facing, limestone talus slopes. Voucher specimens are deposited at the University of Tennessee Herbarium an the Virginia Polytechnic Institute Herbarium.

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[1]Contribution from the Botanical Laboratory, The University of Tennessee, N. Ser. 248

A HYBRID POPULATION OF CLAYTONIA IN VIRGINIA

LEONARD J. UTTAL

An interspecific hybrid population of *Claytonia* (Portulacaceae) is reported for Virginia. Putative parents are the native species of the region, *C. caroliniana* Michx. and *C. virginica* L. The station is in Rockbridge County, 4.5 miles south of Lexington, on the south bank of Buffalo Creek, 0.7 miles west of U. S. Highway 11.

C. caroliniana is abundant on the rich, loamy, forested talus of the north-facing limestone bluff which overlooks Buffalo Creek at this point. This steep habitat is relatively undisturbed. The bluff yields abruptly westward to rolling pasture, deforested and highly disturbed, perhaps, from colonial times. In damp habitats in this zone one finds *C. virginica*. On the border between the two parental habitats there is a broad springy depression in the hillside, highly disturbed, given to weeds and saplings, and used for a brush dump. This is the habitat of the hybrid *Claytonia* population.

Parental populations approach the hybrid habitat, *C. caroliniana* from the east and *C. virginica* from the west, both perfectly identifiable within twenty meters of each other. The hybrid population forms a reticulate link with the populations of the putative parents in that plants carry seemingly unlimited combinations of characters. Leaf width ranges from narrowly linear and apetiolate to broadly lanceolate and petiolate with an entire gamut of intermediacy. Although the hybrid population is not massive (some plants perhaps lying under dumped brush) enough were seen to conclude that gene flow must be thorough and uninhibited. The situation is exactly as one would expect from repetitive prime and back crossing involving true compatibility. Bees were observed to visit indiscriminately all kinds of plants involved in April, 1962 and April, 1963. Chromosomal balance between *C. caroliniana* and *C. virginica* ($2n = 16$) is

Plate 1296. Naturally hybrid *Claytonia* plants from Virginia. A. *C. virginica* from putative parent population. B. *C. caroliniana* from putative parent population. C. Variously intergradient plants from apparent hybrid population.

known to exist (Rothwell, 1959). Fertility of the hybrid plants seems assured.

Claytonia virginica is reputedly a highly variable species, both in cytology and external morphology (Rothwell, l.c., Lewis, 1959, 1962). In Virginia it occupies varied habitats. It tolerates human disturbance of habitat as long as its moisture requirements are met and it is not deliberately or accidentally destroyed.

Claytonia caroliniana is not known to be so variable. Extensive studies have not been applied to this species as they have to *C. virginica*. In Virginia it occupies relatively undisturbed habitats, such as the bases of cliffs. Being essentially a northern species its shade requirements may exceed those of *C. virginica* at the Virginia latitude, thus possibly failing where the forest cover is removed. *Claytonia virginica* may, of course, occur in a similar habitat; if so, *C. caroliniana* is, as a rule, distant.

It is suggested that *C. caroliniana*, in the southern Appalachian region, is a "relict" from an ancient northern reservoir, surviving in habitats that most simulate conditions in the northern heartland of the species. Such habitats in Virginia are usually so fortuitously situated by terrain and patterns of agriculture as to remain relatively undisturbed and isolated from the habitats of the more tolerant *C. virginica*. Thus *C. caroliniana* could develop in isolation from *C. virginica* all the while retaining an original cross-compatibility with its congener. By redundant chance, in this instance, man has perforated the ecological barrier long existing between the two species. The opening up of land close to a population of *C. caroliniana* has provided a habitat suitable to *C. virginica*, the more aggressive species, so that in time the two parental populations were within pollinating distance of each other.

Clearly, the present hybridization is exceptional. Rothwell (l.c.), in his extensive studies, found no adjacent populations of the two species nor any intermediate populations. Thus there remains no reason to question his conclusion that the highly complex chromosomal variation, known in *C.*

virginica, is unrelated to interspecific hybridization. Topography and land use still generally preserve the ecological barrier between the two species, but it seems likely that more intergradient populations will be found in the future, if looked for.

Sheets of specimens pertinent to this paper will be deposited in the herbarium of Virginia Polytechnic Institute.

My appreciation is due Dr. Askel Löve and Mr. Leon Kelso for kind assistance with references.

MADISON HEIGHTS, VA.

Literature Cited

Lewis, W. H. 1959. Three Chromosome Numbers for *Claytonia virginica* (Portulacaceae). Southw. Naturalist **3**:130-132.

———— 1962. Aneusotomy in Aneuploid Populations of *Claytonia virginica*. Amer. Journ. Bot. **49**: 918-928.

Rothwell, N. V. 1959. Aneuploidy in *Claytonia virginica*. Amer. Journ. Bot. **46**: 353-360.

FLORA OF THE WOLF ISLANDS, NEW BRUNSWICK[1,2]

PART 2

SOME PHYTOGEOGRAPHIC CONSIDERATIONS

ALBION R. HODGDON AND RADCLIFFE B. PIKE

In the earlier paper of this series (Pike and Hodgdon, 1963) we presented a list of the vascular plants of the Wolf Islands. With the addition, in a later paper, of 7 more species (Hodgdon and Pike, 1964) and one other in the present study, we now have a basis for comparing their flora with that of Grand Manan (Weatherby and Adams, 1945).

In this discussion we are emphasizing those rather numerous taxa which occur on the Wolves but which are not known from Grand Manan. Though it is true that certain of these may yet be discovered in the latter group of islands, many of the Wolf Island isolates are confined to certain special habitats such as sea-ledges and beaches where they would be conspicuous elements of the flora and thus would not be likely to escape notice. For example, *Conioselinum chinense* which is a prominent plant near the sea on all of the principal Wolf Islands was not discovered on Grand Manan during the many decades of careful botanizing of Weatherby and his predecessors. We also failed to find it or indeed most of the other Wolf Island specialties during several visits to Grand Manan, one notable exception however being *Betula papyrifera* var. *cordifolia* (Hodgdon and Pike, 1962). A

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[1]This research is part of a project entitled "Floristic and Phytogeographic investigations of the Wolf Islands and other islands in the Bay of Fundy" which was supported by grants from the Central University Research Fund of the Graduate School of the University of New Hampshire and the Society of the Sigma Xi. Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as Scientific Contribution No. 340.

[2] We are indebted to Dr. E. C. Smith and Dr. A. E. Roland who gave us much time and help on the occasion of a visit to Nova Scotia while preparing this paper. We also made extensive use of the Harvard herbarium for the use of which we wish to express thanks to the Administrative staff.

pronounced difference in the relative abundance of certain taxa on the two groups of islands is shown by this birch, which is one of the most common trees on the Wolves but on Grand Manan is noticeably rare, and by *Amelanchier Bartramiana* which perhaps occurs on Grand Manan but whose presence there is indicated only by some intermediate individuals between the common *Amelanchier laevis* and *A. Bartramiana.*

Some remarkable and not easily explained deficiencies are to be noted in the flora of the Wolves. No species of *Typha* is found though habitats occur where it would seem that either *T. latifolia* or *T. angustifolia* could survive and spread. Both species occur on Grand Manan. No species of *Sparganium* nor indeed of any species of aquatic vascular plant of fresh water affinity has been found on the Wolves though there are a few brooks which on our numerous visits have always seemed adequate to support *Callitriche.* Neither *Juniperus communis* var. *depressa* nor *J. horizontalis* is found. This is surprising since conditions there seem to be suitable and both are to be found on Grand Manan. The genus *Spartina,* with three species on Grand Manan, is absent from the Wolves. In fact, nearly all of the characteristic salt marsh species of our coast are lacking though there are considerable areas on these islands where salt marsh species other than the commonly occurring *Juncus balticus* var. *littoralis* might be expected. Similarly, although the Wolves have a diversity of bog habitats and a fair representation of bog plants, two are absent there which are common on Grand Manan, *Rubus Chamaemorus* and *Gaylussacia dumosa* var. *Bigeloviana.*

We have been interested to detect pronounced floristic differences between two groups of islands lying fewer than fifteen miles apart, bathed by the same cold Bay of Fundy water and having a rather remarkable degree of apparent similarity in most other ecological features. Certainly the considerable group of islands comprising Grand Manan must be sufficiently diverse ecologically to provide environments comparable to those on the Wolves. How, then, do we account for the differences? It is this provocative question,

more than any other, that has led to our continuing study of these small islands.

In the list that follows we are including only the more clearly defined and less debatable taxa. Our 1963 list reflected a tendency on our part to subdivide species rather more than Weatherby and Adams, at least in some groups. However, whenever subspecific taxa are clearly defined and have long been recognized in the literature, it is assumed that they would have been listed in the flora of Grand Manan had they been found there.

We now feel, after a reappraisal, that a few taxa including *Botrychium simplex* var. *tenebrosum* and *Lycopodium annotinum* var. *alpestre* are better omitted from the Wolf Islands list. The former is probably typical *B. simplex* and the latter should perhaps be included with *L. annotinum* var. *pungens* although some of our specimens compare with extreme specimens of Alpine material from New Hampshire which some botanists have considered, perhaps erroneously, to be var. *alpestre*. In any event, more collections and more study both are needed before precise identifications in some groups seem warranted.

We are also omitting the following long persistent or adventive European plants from present consideration since we do not feel that their being absent from Grand Manan is germane to the present treatment of the relationship of the two island floras, *Rheum Rhaponticum*, *Capsella rubella*, *Senecio vulgaris* and *Hieracium pratense*.

SELECTED LIST OF VASCULAR PLANTS OF THE WOLF ISLANDS, UNKNOWN FROM GRAND MANAN.

Lycopodium annotinum L. var. *pungens* (La Pylaie) Desv.

In the Acadia University herbarium at Wolfville, Nova Scotia, there are specimens of this variety comparable to Alpine material that we have seen from the higher mountains of New England. These are from Cape Breton Island and from Cumberland and Guysborough counties in northern and eastern Nova Scotia. We have seen no typical specimens of *Lycopodium annotinum* on the Wolf Islands and some of the material is quite extreme. Some specimens, however, are difficult to classify having serrate, forwardly pointing or spreading and not reflexed leaves. Specimens are confined to East Wolf Island where considerable variability is shown presumably of genetic origin since the

plants grow under a fair range of environmental conditions and there seems to be no correlation of habitat with the character of plant. The question arises, how does one account for a genetically diverse population on one island and a total absence on nearby islands when in this instance more than one spore must have grown to maturity to initiate genetically distinct kinds of plants.

Ruppia maritima L. var. *longipes* Hagström

The var. *rostrata* is found on Grand Manan. On East Wolf, *Ruppia* occurs in two well separated ponds formed by barrier beaches. Since the varieties of *R. maritima* are very wide-ranging, probably there is no significance in the presence of any particular element of the species on the Wolves. It is of interest, however, that the Wolves and Grand Manan each have two or more colonies of a particular variety not shared with the other area; showing no recent migration of *Ruppia* between the two groups of islands.

Puccinellia laurentiana Fern. & Weath.

Plants of *Puccinellia* are both abundant and variable on all of the Wolves. A few large specimens fit the characteristics of *P. laurentiana* as given in Gray's Manual and match herbarium material of that species. While apparently absent from most of Nova Scotia, certain unnamed specimens from New Brunswick and adjacent Cumberland County, N. S., in the Acadia University herbarium, may belong to this species which otherwise is confined to the region about the Gulf of St. Lawrence and to northern New Brunswick.

P. paupercula (Holm) Fern. & Weath. var. *paupercula*

A number of specimens with small spikelets belong here. We have made very extensive collections of this abundant species most of which belong to the wider ranging and in eastern America more southern var. *alaskana* (Scribn. & Merr.) Fern. & Weath. Our material is extremely varied particularly as to stature and habit. The well-developed "bird lawns" around the edges of most of the Wolf Islands provide a suitable environment for a very extensive and varied growth of *Puccinellia* which with *Euphrasia*, which often grows nearby, constitute the most perplexing genera on the Wolves. The var. *paupercula* seems to have been collected no nearer than the Gulf of St. Lawrence and Cape Breton.

Agropyron trachycaulum (Link) Malte var. *glaucum* (Pease & Moore) Malte

There may be nothing particularly unusual about the absence of this wide ranging taxon from the Grand Manan area. However, in Nova Scotia it has been collected up to now only from the following areas along the Bay of Fundy, Digby Neck to King's County, Cape D'or, Isle Haute and eastern Guysborough County into Cape Breton, a range that is somewhat more extensive in Nova Scotia than most of the other Wolf Island disjuncts but which nonetheless shows a distinctly northern type of distribution. This is perhaps the more inexplicable in view

of the fact that the generally more northern var. *majus* (Vasey) Fern. is found on both the Wolves and Grand Manan and occurs widely in Nova Scotia.

Deschampsia flexuosa (L.) Trin var. *montana* (L.) Ledeb.

In its more extreme phases this is one of the most distinctive of all the geographic varieties of various species that we have found on the Wolves. With compact inflorescences and large spikelets, these plants, which on the Wolf Islands at least are often stoutish, bear very little general similarity to typical *Deschampsia flexuosa* which also occurs on the Wolves. However, many intermediate and perplexing forms are present which are difficult to classify. This is a boreal variety whose southern limits, aside from the Wolves, seem to be St. Paul Island, Nova Scotia, and the mountains of eastern Quebec.

Calamagrostis canadensis (Michx.) Nutt. var. *robusta* Vasey and var. *scabra* (Presl.) Hitchc.

All of our specimens of *C. canadensis* have big spikelets characteristic of these two boreal and montane varieties. The var. *scabra* would seem to be the more significant of the two. In the eighth edition of Gray's Manual (1950) it is recorded as extending on the southeastern part of its range to the Gaspé Peninsula and the White Mountains of New Hampshire while Dore and Roland (1942) specifically state that var. *scabra* has not been found in Nova Scotia. Weatherby and Adams recorded neither variety from Grand Manan and those specimens from there that we have seen are fairly typical *C. canadensis*.

Carex canescens L. var. *canescens* and *C. canescens* var. *subloliacea* Laestad

The less boreal var. *disjuncta* Fern. is present on the Wolves but mostly is supplanted by these two varieties of more northern distribution and smaller or less separated spikelets. In Nova Scotia var. *subloliacea* apparently is very rare being represented from there only by a single collection from Cape Breton Island in the Acadia University Herbarium while var. *canescens* also seems to be confined to Cape Breton Island.

C. echinata Murr.

A most perplexing series of specimens has been collected on East Wolf Island grading into fairly clear *C. angustior* Mackenz. Many of these however are similar in most respects to *C. echinata*, a northern species that occurs south to Newfoundland and eastern Quebec. Some of the specimens in the folders of *C. angustior* in the Gray Herbarium from northern New England and New Brunswick also seem to be close to *C. echinata*. In view of the boreal character of the Wolf Island flora we may be permitted to suggest that our specimens show some introgression between these two species.

C. Emmonsii Dew.

One small colony of this relatively southern species was found growing in turf on a high ledge on the southern side of South Wolf

Island. It grows in Nova Scotia and Prince Edward Island and of course might be sought on Grand Manan.

C. crinita Lam. var. *crinita*

For Nova Scotia Roland (1945, p. 144), states "Scattered from Kings and Cumberland Co. to n. C. Br; . . ." In the eastern part of its range, var. *crinita is* apparently more northern than var. *gynandra* (Schwein.) Schwein. & Torr. which is found on Grand Manan. The range of var. *crinita* includes New Brunswick and Nova Scotia from Yarmouth and Kings Counties to Cape Breton.

C. nigra (L.) Reichard var. *strictiformis* (Bailey) Fern.

When first collected this was assumed to be *C. stricta* Lam. which it resembles superficially. It is quite distinct in appearance from typical var. *nigra* which also grows on the Wolves. This variety apparently overlies the southern part of the range in eastern North America of typical *C. nigra.* Being not particularly boreal it occurs around the periphery of Nova Scotia. Yet it seems to fit the pattern of more boreal taxa by missing Grand Manan.

C. rostrata Stokes var. *rostrata*

This variety whose spikelets have relatively short, broad and mostly acute scales seems to occur no nearer the Wolf Islands than northern Vermont, northern New Brunswick and St. Paul Island, Nova Scotia. Our limited collections of *C. rostrata* also include var. *utriculata* (Boott) Bailey. Our specimens of var. *rostrata* resemble rather closely the specimens we have seen from St. Paul Island collected by Perry and Roscoe in 1929.

Juncus effusus L. var. *Pylaei* (Laharpe) Fern.

This variety of the Common Rush with long, narrow unwrinkled spreading sepals is the only one we have found on the Wolves. In the Acadia University Herbarium no specimens of var. *Pylaie* were seen from western Nova Scotia which fact may be of some interest in relation to the plant's absence from Grand Manan. Two other varieties, *solutus* Fern. & Wieg. and *compactus* Lej. & Court., were reported by Weatherby and Adams from Grand Manan.

Luzula multiflora (Ehrh.) Lej. var. *acadiense* Fern.

In reference to var. *acadiense,* Roland (loc. cit. p. 167) states, "This plant originally described from P.E.I. is rather rare in the northern parts of the province. It is common and the only variety on Sable Island. A collection from St. Paul Island, originally referred to var. *comosa* is considered to belong here." Weatherby and Adams did not subdivide *Luzula multiflora.* Their material that we have seen, however, appears to belong to more wide ranging var. *multiflora.* The var. *acadiense* also is found as a component of the Passamaquoddy flora in Washington County, Maine, and mainland New Brunswick.

Salix pedicellaris Pursh var. *hypoglauca* Fern.

We collected a solitary specimen in a bog on East Wolf where it superficially resembled the abundant *Myrica Gale.* Since Mr. Weath-

erby in 1941 made the first discovery of this plant in Nova Scotia it would seem that he would have found it on Grand Manan had it grown there. In Nova Scotia it seems to be confined to the central counties.

Betula papyrifera Marsh. var. *cordifolia* (Regel) Fern.

In the Wolf Islands this variety is generally common while typical Paper-Birch has been seen only on East Wolf as very scarce specimens. The converse seems to be true of Grand Manan where by diligent hunting we found some specimens in 1964 though Weatherby and Adams had not seen any.

Geocaulon lividum (Richards.) Fern.

There are no specimens of this from Western Nova Scotia in the Acadia University Herbarium but a great many from Cape Breton and some of the eastern counties of Nova Scotia. It has been collected in Washington County, Maine, but otherwise is more characteristic of the northern New England mountains and northward.

Atriplex glabriuscula Edmondston

Weatherby and Adams mentioned the possibility that this species may be present on Grand Manan since it is known from Washington County, Maine and follows the coastline around Nova Scotia. However, *A. glabriuscula* seems to follow the pattern of many other boreal species by missing Grand Manan and appearing on the Wolves.

A. patula L. var. *patula*

No mention is made about the variability of *A. patula* on Grand Manan by Weatherby and Adams. We noted much variability on the Wolves, some specimens falling into var. *patula* by having the principal leaves linear to lance-hastate. Comparable specimens as clearly characterized as ours in the Acadia Herbarium are scarce and are from northern and eastern parts of Nova Scotia.

Ribes hirtellum Michx. var. *calcicola* Fern.

Plants of *R. hirtellum* are abundant on ledges and at the edges of woods on all the principal Wolf Islands. Extreme specimens with strongly pubescent and somewhat cordate leaves occurred on ledges next to the sea on Fatpot Island. The only collection of var. *calcicola* in the Acadia Herbarium from Nova Scotia was from Brier Island which is notable for having many stations of northern disjuncts.

Amelanchier Bartramiana (Tausch.) Roem.

This, the most northern, boreal and montane of our eastern Shadbushes is found on South Wolf and perhaps also on East Wolf and Fatpot where presumed hybrids between it and *A. laevis* have been collected. Though it was not reported by Weatherby and Adams, it may be on Grand Manan since we found a putative hybrid population of *A. laevis* and *A. Bartramiana* there in 1961. On the other hand it is possible that we are witnessing here the swamping out of a species resulting from introgression of a rare species *(A. Bartramiana)* with a much more abundant one *(A. laevis)*. It is well known that these

two species, while clearly distinct in certain habitats, cross very readily when their ranges come together. Some herbaria contain nearly as much hybrid material of these as there are specimens of the distinct species themselves. On Grand Manan the natural tendency to cross has been increased by the changes made by man on the vegetation and the habitat in general. Something similar may have happened to other taxa such as certain of those which now are found on the Wolf Islands and are absent on Grand Manan; certain populations of boreal affinity may once have been there but over the centuries have lost their identities through gene exchange with some compatible and more abundant population of more southern affinity.

The Wolf Islands, with clearly defined and probably relatively stable habitats, are likely to preserve specially adapted populations such as the boreal disjuncts we are concerned with in this paper, while Grand Manan with its greater wealth of habitats may not. In Nova Scotia *A. Bartramiana* seems to be confined principally to the northern and eastern counties.

Rubus pubescens Rab. var. *pilosifolius* A. F. Hill

Some of our specimens fall into this northern and western variety, having leaves velvety pubescent beneath.

Rubus idaeus var. *aculeatissimus* Regel & Tiling

It may seem bold to suggest that this well-marked northwestern American segregate in the *R. idaeus* complex occurs on the Wolf Islands but the plants under discussion have the glandular inflorescences of American *R. idaeus* and canes with stout and somewhat hooked prickles closely resembling herbarium material from the region of the Upper Great Lakes and farther west in North America.

Rubus idaeus L. var. *strigosus* (Michx.) Maxim
and *Rubus idaeus* L. var. *strigosus* forma tonsus Fern.

Here again are instances where the more southern elements of the species appear on the Wolves. We can only suggest that var. *strigosus* should be sought on Grand Manan. However, being bird islands, the extra fertility on the Wolves supplied by gulls undoubtedly has contributed most amazingly to the preservation and proliferation of a good sampling of the different recognized varieties and forms of the American raspberry. There are 5 morphologically defined varieties and forms of *R. idaeus* on the islands, each apparently distinct genetically and each of sufficient taxonomic or horticultural interest to have been given a name or to deserve one. Four of the five already have names; the fifth is the most distinct of all — a member of the var. *canadensis* group lacking bristles which is vigorous and fairly common, being found on several of the islands. Prickles and bristles seem to be very sparsely developed on most of the raspberry canes we have observed or collected on the Wolf Islands except for var. *aculeatissimus*.

Rubus idaeus var. **nesophilus** var. nov.

Forma typica similis, sed aculeis nullis.

Similar to *R. idaeus* var. *canadensis* but canes essentially without bristles. South Wolf Island, edge of shingle beach, August 15, 1960, *Hodgdon & Pike* no. *500* (holotype in University of New Hampshire herbarium (NHA)); Fatpot Island near shore, July 25, 1962, *Hodgdon, Pike, Denbow* and *Burns* no. *501* (NHA).

We cannot find any treatment of a completely bristleless raspberry of *R. idaeus* var. *canadensis* affinity in the literature. This segregate of *R. idaeus* has the characteristic glandularity of American raspberries along with a vestiture of close pubescence on the primocanes, and except for the total lack of bristles would be called var. *canadensis*. This clearly recognizable variety from the Wolf Islands, when considered strictly from the morphological standpoint, provides a pubescent counterpart of *R. idaeus* var. *strigosus* forma *tonsus* Fernald (1919). It is apparent from Fernald's brief discussion and citation of specimens that forma *tonsus* is an occasional variant lacking any well-defined range or particular habitat. Although Bailey (1945) later raised it to varietal rank, Fernald (1950) continued to treat it as forma *tonsus*. We are inclined to agree with Fernald about this taxon on the basis of available evidence but we feel that the bristleless plants of the Wolf Islands belong in the higher category of variety. They constitute an effective breeding population on at least three of the islands. We have collected this unique taxon on South Wolf and Fatpot and have seen it in some abundance on Flat Wolf where it is the predominant type of raspberry. There seems to be some interbreeding between bristleless plants and other populations of raspberry on the islands as shown by the variability of clones but in general var. *nesophilus* is maintaining itself. The bristleless plants possess a high degree of vigor and apparently compete successfully with other vegetation, including other kinds of raspberry. There may indeed be some adaptive genetic factor that favors these plants that lack bristles. A genetically distinct population which seems to be capable of perpetuating itself or even spreading in this somewhat unique environment better fits the category of *varietas* than *forma*.

It seems quite certain that var. *nesophilus* is a bristleless variant of *R. idaeus* var. *canadensis* Richards, and undoubtedly has evolved from it. Thus, we are placing the assumed derived taxon in the same rank as the supposed ancestor. This might be obviated by employing the rank of subspecies to include what now passes as var. *canadensis*.

The origin of our bristleless raspberry offers some problems. It is now sympatric with other raspberry populations with which it appears to hybridize to a certain degree. It may have evolved on these islands quite by itself and later came into contact with other raspberries, or, as in some other known Rubi, it may be a polyploid with a certain degree of but not complete genetic isolation from its

relatives. It is perhaps pure speculation to suggest that a bristleless raspberry would be more likely to succeed on islands apparently free from deer and most rodents than on the mainland or larger islands like Grand Manan.

Rubus vermontanus Blanch.

Three species of the Section *Eubatus* of *Rubus* are on the Wolves but each was found only once and in very limited quantity. On Grand Manan blackberries of several species abound. *R. vermontanus* is one of the more northern species, occurring like *R. canadensis* and *R. elegantulus* as far north as Newfoundland. On Grand Manan *R. vermontanus* may have contributed to some of the puzzling populations of blackberries probably hybrid in nature that have made that island a paradise for batologists.

Lathyrus palustris L. var. *linearifolius* Ser.

Most of our collections of Vetchling, like that from Grand Manan, are the var. *pilosus* (Cham.) Ledeb. However, an occasional plant is nearly or quite glabrous. The var. *linearifolius* according to the range given in Gray's Manual of Botany, eighth edition, would hardly be expected in the Bay of Fundy area or in Nova Scotia but certain specimens in the Acadia University Herbarium from Cape Breton and eastern Nova Scotia resemble our material in having slender winged stems, narrow leaflets and in being quite glabrous.

Hypericum virginicum L. var. *Fraseri* (Spach) Fern.

This is entirely to have been expected on the Wolves. Weatherby and Adams (loc. cit. p. 57) make the following intriguing comment about the species on Grand Manan. "All the material we have examined, however, belongs with typical *H. virginicum*." Roland (loc. cit. p. 356) states of var. *Fraseri* in Nova Scotia, "is more common than the species and is perhaps the only form present eastward."

Viola lanceolata L.

The lance-leaved Violet may have been introduced into the much disturbed area near the lighthouse where it was found in an open and somewhat dry grassy area.

Epilobium nesophilum Fern. var. **lupulinum** var. nov. A forma typica foliis lanceolatis regularibus, apicibus obtusis acutis non attenuatis; calycibus 4.2-5.2 mm. longis, petalis albis differt; a var. sabulonense Fern. follis angustioribus capsulisque pedicellatis 2 cm. longis.

Epilobium nesophilum var. *lupulinum* differs from the typical species in having regularly lanceolate leaves with apices bluntish to acute and not attenuate. Calyx length of 4.2 to 5.2 mm. is in the lowest part of the range to slightly below for the species. The height of the plants from 3 to 5 dm. falls in the low middle range of the species. The color of the petals is white as distinct from pink in the species description.

The var. *lupulinum* differs from var. *sabulonense* in having much

narrower leaves. The measurements of median leaves of ten specimens range from 25 to 37 mm. (av. 32.5 mm.) in length by 4 to 8 mm. (av. 6.3 mm.) in width. Pedicel lengths are from 4 to 21 mm., the latter being 6 mm. longer than the longest given for var. *sabulonense*. NEW BRUNSWICK: in sphagnum along small brook at northern end of East Wolf Island, July 27, 1962, *Hodgdon & Pike*, no. *1000*, (holotype in University of New Hampshire herbarium (NHA).

Epilobium nesophilum var. *lupulinum* is another variety of this island-loving *Epilobium* which is as distinct as the Sable Island variety described by Fernald (1918). We found a colony of this interesting segregate growing in wet sphagnum along a small brook near the northern end of East Wolf Island, New Brunswick. While the Wolf Islands are not as remote geographically as Sable island, they display some evidence of biological isolation which would have allowed similar evolutionary mechanisms to function in the production of a distinct insular form. Probably not more than fifty plants were present of which we collected ten representative specimens. The small size of this population and the restricted habitat, along with the isolation of the islands themselves, would indicate a closely inbreeding group. Such conditions would offer a favorable opportunity for the appearance and fixing of the genetic characters of either adaptive or nonadaptive significance which make this a distinct variety. It being quite unlike any other *Epilobium* with which we were familiar, we have only recently identified our material and in fact have not included it in any of our published lists.

In carefully scrutinizing the very few brooks which occur on the Wolves in the expectation that we might disclose interesting aquatic or subaquatic plants, we have seen no other colony of this variety and it is entirely possible that this one small group represents the entire population. Without much doubt, here is an instance where the Sewell Wright effect might be invoked as an explanation of this variety. At least it would be hard to see how such differences as are shown between this variety and the remainder of the species could have survival value.

In addition to the purely taxonomic interest of this particular find, it also represents a considerable extension of range for the species. Previously, *E. nesophilum* has been found in Newfoundland, the Magdalen Islands, Anticosti Island and Sable Island and thus further emphasizes the boreal character of the Wolf Island flora.

Conioselinum chinense (L.) BSP.

It was the abundance of Hemlock-parsley on all the wooded Wolf Islands and the lack of it on Grand Manan that more than any other single factor led us to a detailed study of the two groups of islands. It is a common and perfectly obvious species growing at or near the edges of woods above sea ledges or beaches, often within reach of sea-spray, and, as depauperate individuals, sometimes found in cracks and

crevices of ledges. In Nova Scotia it is known along the edge of the Bay of Fundy, on St. Paul Island off Cape Breton, and in a few localities in eastern Nova Scotia. Except on St. Paul Island it is stated by Roland to be scarce. No mention is made by Fernald in Gray's Manual, edition 8, of a coastal type of habitat for *Conioselinum*. Yet it is evident from data on herbarium specimens that in the more coastal part of its range it often frequents habitats similar to those on the Wolves — rocky coast, sea-cliffs or ledges near the sea.

Vaccinium Oxycoccus L. var. *ovalifolium* Michx.

Weatherby and Adams recorded *V. Oxycoccus*, not specifying any variety, on Grand Manan. Roland, treating it as var. *intermedium* Gray, stated that it was rare in Nova Scotia. On the Wolves it is perhaps more abundant and certainly more conspicuous than the more narrow-leaved var. *Oxycoccus*. In fact, for some time we assumed that all of the Wolf Island material belonged to the broader leaved type.

Lomatogonium rotatum (L.) Fries var. *americanum* (Griseb.) Fern.

Our station for this on South Wolf seemed for a while to be the only one between Schoodic Peninsula on the Maine Coast and the Magdalen Islands. The recent discovery of it on two islands in Washington County, Maine, (Pike 1963) expands the range into the Passamaquoddy area. This is further evidence to show that the Wolf Islands contain an integral part of the Passamaquoddy flora.

Euphrasia canadensis Townsend

The Eyebrights deserve a special study on the Wolves. They are exceedingly common in open situations, particularly on bird-lawns and in woods openings. The small flowered *E. Randii* Robins. is highly variable and common while the larger flowered *E. canadensis* and *E. americana* Wettst. are even more abundant. We have collected extensively of these variable populations and find them difficult to classify. Ecological variability in particular seems to be considerably greater than is indicated in most treatments of the group. *E. canadensis* was not reported from Grand Manan nor any varieties of *E. Randii*.

Plantago juncoides Lam. var. *glauca* (Hornem.) Fern. and *Plantago juncoides* Lam. var. *laurentiana* Fern.

Most of the plants we have seen of *P. juncoides* belong to var. *decipiens* (Barn.) Fern. Locally on East Wolf Island we found tiny plants with abbreviated spikes conforming to var. *glauca*. Some plants on South Wolf with very long and wide leaves, representing the other extreme of size, fit var. *laurentiana*. These varieties are found in northern and eastern Nova Scotia. The var. *glauca* extends southwestward into eastern Maine. Both varieties are unreported from Grand Manan.

Galium labradoricum Wieg.

When we saw this species for the first time in a bog on East Wolf

Island we were struck by its stiff and erect though slender branches quite unlike any *Galium* with which we were familiar. It is a species of northern affinity of apparently somewhat scattered occurrence in Coastal Maine and greater abundance farther north and west. In the Acadia University Herbarium there are Nova Scotian specimens from Cape Breton.

Lonicera villosa (Michx.) R. & S. var. *Solonis* (Eat.) Fern.

This is the common variety of *L. villosa* on the Wolves where it occurs in some abundance on East Wolf Island. Grand Manan had var. *calvescens* (Fern. & Wieg.) Fern. and var. *tonsa* Fern. which also is found on East Wolf, though less commonly than var. *solonis*.

Aster umbellatus Mill. var. *pubens* Gray

There is a wide range of variability in *A. umbellatus* on the Wolf Islands. In general it is a very common species, particularly whenever the substrate has been fertilized by gulls. Part of the variability may almost certainly be a direct response to the environment. Certain extreme forms, however, are not to be explained this way. They have the characters given in the eighth edition of Gray's Manual for var. *pubens*, including the upper surfaces of leaves and upper parts of stems scabrous, leaves tomentulose beneath, phyllaries acutish, pubescent on the back, etc. We have collected var. *pubens* on three of the Wolf Islands. This variety seems to be western with a range somewhat comparable to that of *Rubus idaeus* var. *aculeatissimus*, getting about as far eastward as Michigan.

Anaphalis margaritacea (L.) *Benth. & Hook.*
var. *subalpina* Gray

This variety is mostly western and northern in distribution. It is apparently common on Sable Island but apparently does not occur otherwise in Nova Scotia (Roland loc. cit. p. 501). Some of our specimens seem to belong here. Probably the others should be identified as var. *angustior* (Miquel) Nakai.

Achillea borealis Bong.

Yarrows are common and, like *Aster umbellatus*, *Aster foliaceus*, *Rubus idaeus* and several other species of herbaceous plants, grow most luxuriantly in gull infested sections of the Wolves. Plants of yarrow become disproportionately large and defy identification. We have made a careful study of our fairly numerous collections. On most specimens the phyllaries are dark-margined and some specimens on each of the islands fall within the range of characteristics of *A. borealis*. As a whole the plants are difficult to classify and perhaps in general represent an introgressed series with *A. lanulosa* Nutt. or *A. Millefolium* L.

GEOGRAPHIC RELATIONS

Weatherby and Adams attempted to show the more readily apparent phytogeographic relationships of the Grand Manan

flora by setting up categories of species having similar patterns of distribution. Three of their groupings embracing 22 species, 10 of which are shared with the Wolves, are of boreal or nearly boreal affinity. Since some 33 of the Wolf Island disjuncts that we have discussed in this paper are similarly of boreal or subboreal character we find that a total of 43 Wolf Island taxa are boreal as against 22 from the Grand Manan group. The two island groups together have 55 taxa of northern affinity, of which the Wolves have 78% and Grand Manan only 40%. Assuming that there are some inadequacies both in collecting and interpreting the plants of one or both groups of islands, we are confronted nonetheless with a considerable difference between them that can hardly be shrugged aside. Both groups of islands have been botanized rather closely and critically, Grand Manan by a number of botanists over a long period of time and the Wolves very intensively in recent years by ourselves. Our goals have been to compile a complete list of its vascular plants and to get a sampling of variability in its taxa whenever it seemed warranted. We can state with assurance that the boreal varieties of species complexes are at least as abundant in most cases as their more southern counterparts. In fact, in our collecting on the Wolves we have had to search more diligently for the southern than for the boreal varieties. The disparity between the Wolves and Grand Manan therefore would not seem to result from any bias in collecting. Moreover, we feel that, quite aside from the list and what it reveals, the vegetation of the Wolf Islands has a boreal aspect.

It is evident then that our main phytogeographic problem relates to this remarkable concentration of boreal species and varieties on the Wolf Islands. Under the discussion above of *Amelanchier Bartramiana* we tried to show how one species of greater abundance, *A. laevis*, may have absorbed or swamped out another genetically compatible and more boreal species, *A. Bartramiana*, when conditions were suitable. Some other of the boreal species on the Wolves are parts of species complexes that have presumably compatible

and more southern elements on Grand Manan. In theory it would have been possible for these more boreal populations to have existed on Grand Manan in the past and subsequently to have been absorbed into the more southern populations. On a fairly large island mass the presence of relatively larger populations of the latter (warm) type may well have speeded the introgression. Also the effects of climatic change may have been much more pronounced on large and relatively high islands than on the Wolves. The climatic optimums of recent geologic time thus may have eliminated some boreal taxa from Grand Manan while the Wolves still would have much more closely reflected the stabilizing and somewhat refrigerating influences of the Bay of Fundy. In this way we might account for some of the differences between the two areas, considering, for example, complex species like *Calamagrostis canadensis* or *Carex canescens* with integrating and presumably interbreeding varieties. Perhaps also the differences in *Amelanchier* and the *Rubus idaeus* mélange can be explained in this manner. However, a considerable number of characteristic boreal specialties of the Wolves, such as *Galium labradoricum*, *Salix pedicellaris* var *hypoglauca*, *Geocaulon lividum*, *Atriplex glabriuscula*, *Conioselinum chinense* and *Lomatogonium rotatum*, to name but the more striking examples, should have persisted on Grand Manan in the usual habitats if they had ever been there. Ecologic change can hardly have eliminated all of these and it would seem that they would hardly have lost out by exchanging genes with anything else. It would seem that these are fully as suited to the Grand Manan area as to the Wolves. Something of a pattern of distribution is suggested involving not only these but quite probably a major part of the Wolf Island disjuncts — a pattern that relates to connections to the mainland. The Bay of Fundy between the Wolves and the Coast of Maine and New Brunswick is shown on hydrographic charts as being somewhat more shallow than it is between Grand Manan and the Wolves or between Grand Manan and the Coast of Maine and New Brunswick. We suggest that the boreal disjuncts of the Wolves, in part

at least, represent a residual flora which came overland or essentially so from what is now the Maine and New Brunswick areas (Mainland Passamaquoddy) at a different time from any migration overland to Grand Manan and this fact in part accounts for the close affinity of the flora of the Wolves to the mainland. Grand Manan on the other hand must have been connected at some other time or in some other way to the mainland and presumably also derived a considerable part of its flora from the region of Western Nova Scotia. Post-Pleistocene history is not revealed clearly enough to any more than suggest this hypothesis. But other studies that we have in progress involving other islands in the Bay of Fundy, such as Isle Haute, show quite clearly the necessity of a land connection to have provided a route for certain species of the present flora to have reached that island.

Whatever may have been the migrational history of the areas under scrutiny only those species will persist which can adjust to the local environmental regime and changing conditions.

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Literature Cited

Bailey, L. H. 1945. Gentes Herbarium 5, fasc. X: 870.

Dore, W. F. and A. E. Roland. 1942. The Grasses of Nova Scotia. Proc. Nova Scot. Inst. **XX**, Part 4: 241.

Fernald, M. L. 1918. Rhodora **20**: 31.

———. 1919. Rhodora **21**: 96-97.

———. 1950. Gray's Manual of Botany. 8th Ed., Amer. Book Co., N. Y.

Hodgdon, A. R. and R. B. Pike. 1963 The Flora of the Wolf Islands, New Brunswick. Part 1. Rhodora **65**: 82-96.

———. 1964. Additions to the Wolf Islands Flora, 1963. Rhodora **66**: 61-62.

Pike, R. B. 1963. Rhodora **45**: 364-366.

Roland, A. E. 1945. The Flora of Nova Scotia. Proc. Nova Scot. Inst. XXI part 3.

Weatherby, C. A. and J. Adams. 1945. List of the Vascular Plants of Grand Manan. Contr. Gray Herb. **CLVIII.**

THE STATUS OF *AGANIPPEA BELLIDIFLORA* (COMPOSITAE-HELIANTHEAE)

A. M. Torres and J. H. Beaman[1]

The genus *Aganippea* has been monotypic, containing only the Mexican endemic *A. bellidiflora*, since Blake (1930) placed *A. dentata* DC., the only other described species, in synonymy with *Sabazia humilis* (H. B. K.) Cass. Bentham (1873, p. 438) assigned *Aganippea* to the subtribe Zinninae because of its nearly sessile ray corollas which he erroneously considered to be persistent on the ripe achenes, and because of the absence of a pappus. Hoffmann (1894) followed Bentham in including the genus in the Zinninae where its position until now has been accepted.

During studies of the Zinninae, Torres noted that *Aganippea* was anomalous in that subtribe in several characters. In a discussion of the problem, Beaman suggested the possibility of a relationship between *Aganippea* and *Jaegeria*. Our subsequent examination of herbarium material resulted in the conclusion that *A. bellidiflora* was so similar to several species of *Jaegeria* that it could not be maintained as a separate genus — thus we make the following transfer.

Jaegeria bellidiflora (Moc. & Sessé ex DC.) Torres & Beaman, comb. nov.

Aganippea bellidiflora Moc. & Sessé ex DC. Prod. 6:3. 1838. Type: Calques des Dessins, Flore du Mexique de Mociño et Sessé, *t. 700* (G, original; MO, blueprint copy!; F, photo no. 30737!).

Heliogenes longifolia Benth. Pl. Hartw. 42. 1840. Type: Regla, *Hartweg 323* (K, holotype!; MSC, photo!).

Characters which relate *Jaegeria bellidiflora* to other species of *Jaegeria* and distinguish it from the Zinninae are given in the following table.

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[1]This paper is the result of an informal discussion during the 1963 Symposium on Systematics at the Missouri Botanical Garden. The facilities of the Garden and the library assistance of Dr. G. B. van Schaack are gratefully acknowledged. The study was supported indirectly by National Science Foundation Grants G-25125 (to Torres) and G-23187 **(to Beaman).**

Jaegeria bellidiflora and related species of *Jaegeria*	Zinninae
Plants emergent aquatic, rhizomatous	Plants terrestrial, not rhizomatous
Phyllaries in two equal series	Phyllaries imbricated
Phyllaries with scarious, winglike basal portions enveloping the ray achenes	Phyllaries without winglike basal portions enveloping the ray achenes
Ray corollas deciduous, constricted at the point of attachment to the achene	Ray corollas persistent, not constricted at point of attachment to the achene
Disk corollas with abrupt basal constrictions	Disk corollas without abrupt basal constrictions

The only significant character common to *Jaegeria bellidiflora* and the Zinninae is the nearly sessile ray corollas. This character, however, is almost duplicated in several other species of the genus. *Jaegeria bellidiflora* is morphologically most similar to *J. pedunculata* Hook. & Arn. and *J. purpurascens* Robins. from which it differs in its larger size, fewer branches, fewer heads, and other minor characters. It attains a greater size than any other member of the genus.

Jaegeria was placed by Bentham (1873) and retained by Hoffmann (1894) in the subtribe Verbesininae. We suspect that this classification is not entirely satisfactory, but thorough studies or a number of genera in the subtribes Verbesininae and Galinsoginae must be undertaken before realignments can be made. The removal of *Aganippea* from the Zinninae, however, results in a better structure of that subtribe.

Bentham's genus *Heliogenes* has long been considered synonymous with *Aganippea*. From a photograph of the type of *Heliogenes longifolia*, we are confident that it is identical with *Jaegeria bellidiflora*. The disposition of *H. reglae* Benth. (the only other species of *Heliogenes* described) is problematical. From a photograph of the type, we suspect that it may be the same as *Jaegeria pedunculata*. Direct observation of the specimen will be required, however, before its status can be properly determined.

The following description of *Jaegeria bellidiflora* will amplify its previous rather brief descriptions.

Perennial, emergent aquatic, erect herb, ca. 5-10 dm. high; rhizomes thick, hollow, with opposite scale leaves and fibrous roots at the nodes; stems thick, hollow, striate, glabrate to sparsely pilose below, becoming densely pilose above; stem leaves opposite, sessile-clasping, inconspicuously dentate-serrate, lanceolate, with three principal parallel veins, up to 8.5 cm. long and 1.7 cm. wide, glabrate above, sparsely pilose below, especially on the veins; peduncles axillary, solitary, slender, pilose to densely pilose-strigose, ca. 7 cm. long; heads campanulate, ca. 1 cm. high, 2.3 cm. wide (including the rays); phyllaries 2-seriate, linear-lanceolate, herbaceous, 3-4-nerved, the lower 1/3 abruptly expanded into scarious wings enveloping the ray achenes, the lower portion hirsute-pilose on and near the nerves, the upper portion glabrous except for a few appressed hairs on the margins; rays pistillate, fertile; ray corollas white, ca. 12 mm. long, 3 mm. wide, the short tube ca. 0.2 mm. long, apices minutely 2-lobed to entire; style branches of the ray short, lanceolate, flattened, glabrous, the apices obtuse; disk flowers hermaphroditic, fertile; disk corollas yellow, ca. 3 mm. long, tube basally constricted for ca. 0.8 mm., densely pilose on the constriction, glabrous above; style branches of the disk flattened, lanceolate, papillose-pubescent, the papillae longer near the obtuse apex; anthers loosely connate, the bases sagittate, the apical appendages ovate; achenes dark brown, minutely striate, shiny, oblanceolate, those of the ray mostly 3-angled, those of the disk 4-angled; pappus absent; receptacle rounded-conical, ca. 4 mm. long, paleaceous; paleae scarious, 3-nerved, broadly oblanceolate, glabrous, ca. 3.5 mm. long, the upper portion lacerate-ciliate.

The species occurs in shallow water of small streams, ponds, or marshes at elevations of about 2,000 to 2,700 meters in or near the trans-Mexican volcanic zone of south-central Mexico.

Representative specimens: MEXICO. FEDERAL DISTRICT: Xochmilco [Xochimilco], 7,480 ft, *G. L. Fisher*, 1924 (MO); Valley of Mexico, 7,300 ft, *Pringle 6230* (F, MO, MSC); Valley of Mexico, 7,300 ft, *Pringle 9839* (F, MO); Churnbusco, *Orcutt 4277* (F, MO). HIDALGO: Regla, *Hartweg 323* (K, holotype of *Heliogenes longifolia*). STATE OF MEXICO: 1 km NW of Del Río Station, ca. 20 km. NW of Toluca, ca. 2,550 m. alt., *Beaman 4236* (MSC, UWM); Lerma, *Martínez 15129* (MO). MICHOACAN: vicinity of Morelia, 1,950 m., *Arsène 8577* (F, MO); vicinity of Morelia, Rio Grande, *Arsène*, 1912 (MO). PUEBLA: Cholula, 2,170 m., *Arsène & Nicolas 5253* (MO).

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LITERATURE CITED

BENTHAM, G. 1873. Notes on the classification, history, and geographical distribution of Compositae. Jour. Linn. Soc. Bot. **13:** 335-577.

BLAKE, S. F. 1930. Notes on certain type specimens of American Asteraceae in European herbaria. Contrib. U. S. Nat. Herb. **26:** 227-263.

HOFFMANN, O. 1894. Compositae, *in* Engler & Prantl, Natür. Pflanzenfam. 4^5: 87-391.

MAGNOLIA GRANDIFLORA IN GRAY'S MANUAL RANGE — Some groups of very old trees of *Magnolia grandiflora* L. were discovered growing in sandy soil of a swamp in Princess Anne County, Virginia during the course of mid-winter field work on the vegetation of Virginia. Many seedlings of various sizes were also growing in the area.

The northern edge of the magnolia swamp occurs about two miles southeast of Pungo. The area of magnolias extends for about a mile southward and is more than one-half mile wide in places. The land has been partially drained and some of it is cultivated; other areas are used for hog-runs. Drainage operations were going on at the time of collecting the specimens.

An attempt to count the magnolia plants was started, but was abandoned when it became evident that the number would run into the hundreds. Some associates of the magnolia in the Virginia locale are *Pinus taeda, Ilex vomitoria, Persea borbonia, Liquidambar styraciflua, Myrica cerifera, Gelsemium sempervirens,* and *Baccharis halimifolia.*

After seeing prized specimens of *Magnolia grandiflora* in such far-away places as Oxford, England; Cairo, Egypt; and the Canary Islands, it is of considerable interest to find this strikingly-beautiful American tree growing in a region which has been settled for three centuries, and to add it to the range of Gray's Manual, which has included Virginia for 107 years.

Specimens of the *Magnolia, Harvill 11044,* are deposited in the herbarium of Longwood College.

A. M. HARVILL, JR.,
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APPLICATION OF THE NAME KUHNIA EUPATORIOIDES VAR. ANGUSTIFOLIA (COMPOSITAE). — The monumental new *Flora of Missouri* by Julian A. Steyermark (1963) follows Fernald's 8th edition of *Gray's Manual* (1950) in reviving the name *Kuhnia eupatorioides* var. *angustifolia* Raf., New Fl. N. A. **1**:79, 1836, but applies it more particularly to the plants described by me as *K. eupatorioides* var. *ozarkana* (Wrightia **1**:136, 1946), that name being treated as a synonym. In my "Revision of the genus *Kuhnia* L." (Wrightia **1**:122-144. 1946), var. *angustifolia* is given as a synonym of *K. eupatorioides* var. *pyramidalis* Raf., the name employed under then existing rules of nomenclature for what is now to be called var. *eupatorioides*. Because two authoritative works have, subsequent to the publication of my revision, adopted the name var. *angustifolia*, I feel obliged to point out that it is untenable.

In his rather extensive "Monograph of the genus *Kuhnia*" (New Fl. N. A. **1**: 73-80. 1836), Rafinesque tells of having found *K. eupatorioides* "exactly as described by Linneus" on "Rocky banks of the R. Schuylkill near Philadelphia, in a single spot near the rail road bridge: 3 varieties." He then names the three varieties as *pyramidalis*, *corymbosa*, and *angustifolia*, adding: "These 2 last are probably the *Critonia* of Gaertner and others, yet they are perhaps nothing else but various ages of the plant? but since they have been mistaken for species, they must be properly noticed." He was, of course, describing what we should now designate as forms, not geographic varieties, all three of them growing, in his own words, "in a single spot," and that spot in the general area of the type locality for the species. Fernald, in assigning to var. *angustifolia* the range "Fla. to Tex. and Mo.," apparently excludes its own type locality. Steyermark, in applying the name to var. *ozarkana* Shinners while quoting Fernald as to the range, compounds the error, for plants with the distinctive, long-attenuate, outer phyllaries of var. *ozarkana* do not occur in most of the stated area.

LLOYD H. SHINNERS,
SOUTHERN METHODIST UNIVERSITY, DALLAS.

NEW RECORDS AND NOTES ON PLANTS OF KANSAS — Field studies, during the summer of 1963, associated with my research on the genus *Eleocharis*, have revealed some new vascular plant records for the state as well as additional distributional records of some little known species of the Kansas flora. Specimens new to the state are on deposit in the herbarium of The University of Kansas.

SPECIES NEW TO KANSAS — *Juncus polycephalus* Michx. HARVEY CO.: sand dune pond area, 3½ miles north of Burrton, 7 September, 1963, *L. J. Harms 1228*.

This plant is reported as a southern, Gulf Coast species (Florida to Louisiana and north to North Carolina; doubtful to Oklahoma). The plants, although "rare," were associated with another predominantly coastal species, *Eleocharis atropurpurea* (Retz.) J. & C. Presl, also known from this locale. (Rhodora 62:93. 1960.)

Fimbristylis vahlii (Lam.) Link. WOODSON CO.: edge of Yates Center City Lake, 9 November, 1963, *D. Farr*.

Svenson (N. Am. Flora 18(9) :554. 1957.) gives the range of this species as North Carolina to Florida, west to Texas and Missouri (also known from Oklahoma). This range now is extended north and west into Kansas.

Eleocharis smallii Britt. On the basis of more recent work by Svenson (Rhodora 49:61-67. 1947.) and unpublished research by myself, I feel it necessary to distinguish this species as a member of the Kansas flora, which Svenson (annotated specimens in the Kansas State University Herbarium) and correspondingly Gates (Flora of Kansas, 1940.) have previously included under *Eleocharis macrostachya* Britt. A representative collection is as follows: STAFFORD CO.: saline ditches 4 miles east of Ellinwood, 12 June, 1963, *L. J. Harms 1078*.

Marsilea quadrifolia L. CHEROKEE CO.: roadside ditch, 5 miles west, 2¼ miles south of Melrose, 20 June, 1963, *L. J. Harms 1137*.

Common in ditches and, for the present, restricted to this county extending the range west from Missouri.

NOTES ON DISTRIBUTION AND TAXONOMY — *Juncus validus* Coville. Species formerly known only from Chautauqua

County. The range has now been extended to the southeast corner of the state north and west to central Kansas. CHEROKEE CO.: common in the flood plain swale of Neosho River, 4 miles south of Melrose, 20 June, 1963, *L. J. Harms 1182*. HARVEY CO.: sand dune pond area, 3½ miles north of Burrton, 7 September, 1963, *L. J. Harms 1234*.

Eleocharis rostellata Torr. A southwestern U. S. species previously known from central Kansas (Stafford Co.) west to Meade County. It now is known from the southwest corner of the state (Morton Co.) north to Scott County and the northwest corner of Cheyenne County. The species known only from isolated locales and the colonies always are associated with a permanent water source.

Eleocharis wolfii A. Gray. Upon viewing the determinations of this species by H. K. Svenson, in 1939, of Kansas State University Herbarium material, I found that Svenson, perhaps through error in labeling, had misdetermined all but a single specimen: CHEROKEE CO.: 6 May, 1897, *Hitchcock 1050*. The other specimens are *Eleocharis compressa* Sull. The distribution reported by Gates (Flora of Kansas, 1940), based on the determinations of Svenson, should be amended and limited to Cherokee County.

LARRY J. HARMS, DEPARTMENT OF BOTANY
THE UNIVERSITY OF KANSAS, LAWRENCE

A RARE BLUE-GREEN ALGA FROM MASSACHUSETTS — Hampshire county in western Massachusetts, in contrast to the eastern part of the state, is a region for which no detailed knowledge of the algae exists. Of particular interest, then, are the rather rare algae which may be encountered in such an area.

During a preliminary investigation of several freshwater habitats near Amherst, such an alga, *Nostochopsis lobatus* Wood was collected. The gelatinous colonies of this species, resembling those of *Nostoc* in habit, were attached to shaded rocks in the gently flowing water of Bachelor Brook, South Hadley, Massachusetts. These plants, growing in association with *Cladophora* sp. and *Oedogonium* sp., were first collected in July; at this time, the water temperature was 24° C. and the pH was 7.6.

The basal cells of the trichomes are somewhat rounded, constricted at their septa, and measure 2.1μ × 3μ; the distal cells are conspicuously narrower, lack constrictions, and measure 1.4μ × 3.5μ. The lateral heterocysts are either

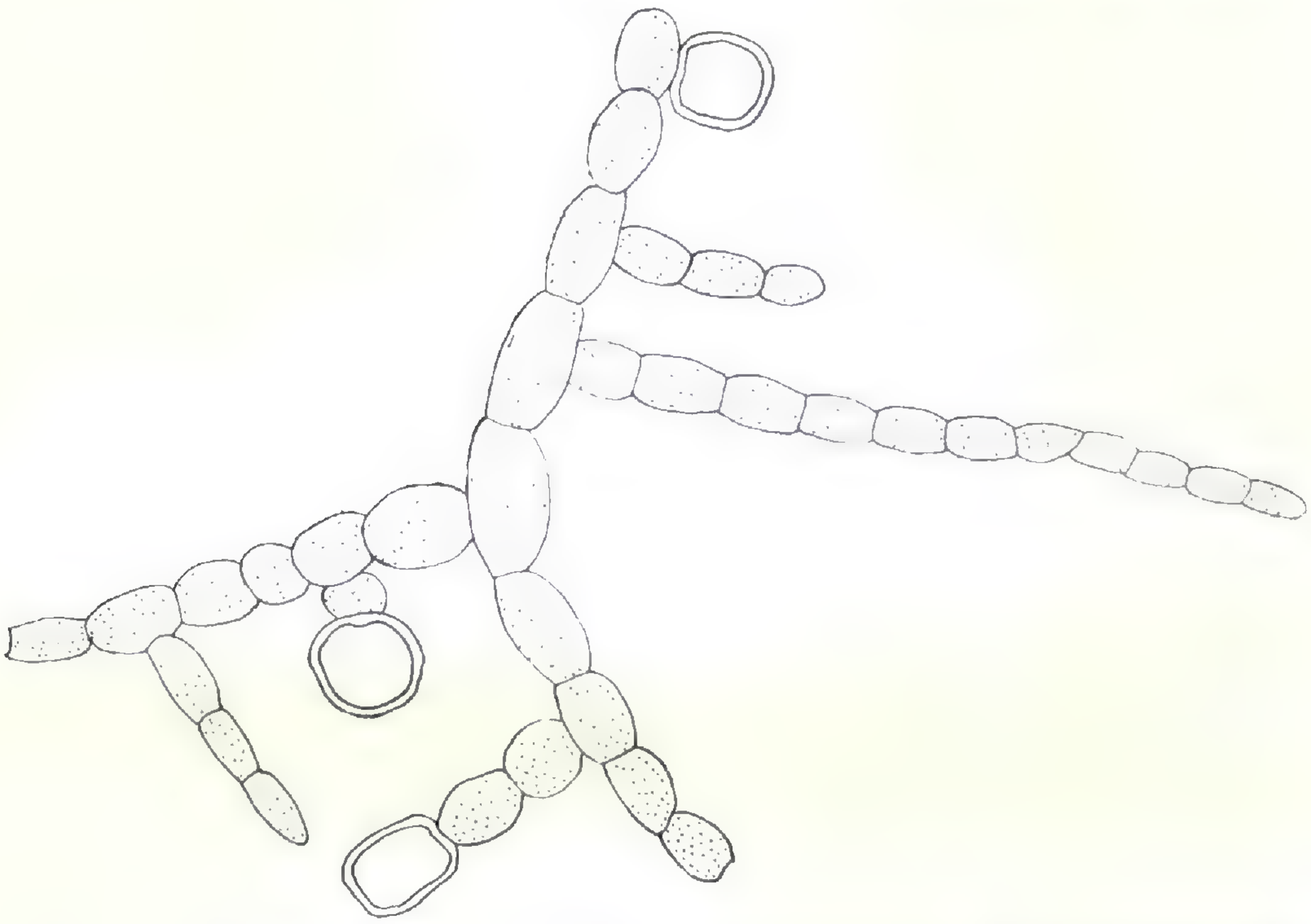

Fig. 1. *Nostochopsis lobatus* Wood showing the lateral heterocysts and manner of branching, ca. × 660.

sessile or terminal on very short branches. True branching is present (Fig. 1).

According to Geitler (2), trichomes of *Nostochopsis lobatus* vary in width from 2μ to 9μ. Tilden (3) presents trichome widths of 4μ to 9μ for the then recorded New England representatives of this species. It is interesting, therefore, that these Massachusetts plants from South Hadley, collected over a period of several months, have consistently exhibited the minimum cell-width range possible within the species.

Although several species of *Nostochopsis* are known from Europe, only one species, *N. lobatus*, is known to occur in the United States. Its pattern of distribution here is mainly along the eastern and southeastern coast, although it has been collected in Indiana, Arizona, and Washington (1).

Therefore, these current records of *Nostochopsis lobatus* are of special interest. They not only represent the first published account of its presence in Massachusetts, but they also appear to illustrate the extreme minimum cell width possible within the species.

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LITERATURE CITED

1. DROUET, F. Academy of Natural Sciences. Philadelphia. Personal communication.
2. GEITLER, L. 1925. Die Susswasserflora. Heft 12. Jena.
3. TILDEN, J. 1910. Minnesota Algae. Minneapolis.

ILLINOIS FLORA: NOTES ON LEPTOCHLOA AND LYCOPODIUM: — While botanizing on October 10, 1963, along the shore of Horseshoe Lake, in the bottomland of the Mississippi River, west of Pleasant Hill, Pike County, Illinois, I discovered a stand of *Leptochloa panicoides* (Presl) Hitchc. [*Diplachne halei* Nash]. This grass had never been collected in Illinois. Kucera (The Grasses of Missouri, 1961, p. 138) reported its occurrence in Missouri on "open sandy banks of Mississippi River, New Madrid County." and Deam (Flora of Indiana, 1940, p. 142) described its presence and manner of growth in Pitcher's Lake, west of Mt. Vernon, Posey County, Indiana. The Illinois stand lies nearly 185 miles west-northwest of the Indiana site, just over 200 miles north-northwest of the Missouri locality, and is a northward extension of the range of this species by approximately 100 miles.

I collected only two samples on the October 10 visit to Horseshoe Lake. To permit a distribution of specimens to other herbaria, I returned on October 29, collected more samples, and photographed the plants. I then drove south from Pleasant Hill along Illinois highway 96 to the village of Mozier, Calhoun County, where I saw a dry pond bed and stopped to examine it. I was pleasantly surprised to find *Leptochloa panicoides* growing abundantly and made ample collections. The following records represent specimens in the herbarium of the Illinois Natural History Survey (ILLS) and elsewhere:

CALHOUN CO.: dry pond bed at Mozier, October 29, 1963, *R. A. Evers 78671*. PIKE CO.: shore of Horseshoe Lake, west of Pleasant Hill, October 10, 1963, *R. A. Evers 78504;* October 29, 1963, *R. A. Evers 78660*.

On April 8, 1963, Dr. Warren H. Wagner, Jr. and I were looking for fern gametophytes in Jackson Hollow, Pope County, and discovered a sizable colony of *Lycopodium porophilum* Lloyd & Underw. on one of the huge sandstone blocks that are so common on the slopes of this ravine. This species had been previously reported from three northern Illinois counties, Cook, LaSalle, and Ogle. At a later date, Dr. Wag-

ner examined all of the specimens of *Lycopodium* in the Survey's collections and determined a sample from The Pounds, labelled *L. lucidulum*, to be *L. porophilum*. The following records are from specimens in the Survey herbarium:

GALLATIN CO.: on sandstone, The Pounds, southwest of Gibsonia, October 23, 1959, *R. A. Evers 63226*. POPE CO.: on sandstone cliff, Jackson Hollow, southwest of McCormick, April 8, 1963, *R. A. Evers 75740;* November 13, 1963, *R. A. Evers 78690*.

The clubmoss *Lycopodium complanatum* L., var. *flabelliforme* Fern. has been known to occur on a sandstone cliff along Lusk Creek, Pope County, since Voigt and Swayne collected it in 1952. In "Some Unusual Natural Areas in Illinois and a Few of Their Plants" (Ill. Nat. Hist. Surv. Biol. Notes, no. 50, p. 29) I described the Lusk Creek locality as "the only known site for this species in Illinois." On July 17, 1963, Mr. Floyd A. Swink, Morton Arboretum, Lisle, and I botanized in the Chicago area. In the Dan McMahon Forest Preserve, near Palos Park, Cook County, Mr. Swink took me to a colony of this clubmoss, 1.5 meters long and 1 meter wide, growing among bunches of *Andropogon gerardi*. The collection made at that time is in the Survey herbarium *(R. A. Evers 77193)*. Mr. Swink later told me about a colony that appeared spontaneously in a Norway spruce planting in the Morton Arboretum. The spruce trees were planted in 1922. The clubmoss appeared at least 15 years ago. On December 6, 1963, Mr. E. L. Kammerer of the Arboretum collected a specimen from this locality in DuPage County and Mr. Swink kindly forwarded it to the Survey herbarium.

On September 10, 1963, Thomas Brodene of Chicago sent me a specimen of *Lycopodium complanatum* var. *flabelliforme* that he and a friend had collected on August 18 in the Ned Brown Forest Preserve, west of Des Plaines, Cook County. The colony, according to Mr. Brodene, was 10 feet in diameter and in the border of a red oak woods and a hawthorn clearing. A specimen *(Valdemar Schwarz & Thomas Brodene 2242)* is in the Survey herbarium.

The discoveries of Messrs. Swink, Schwarz, and Brodene clearly show that local botanists and botanizers can often contribute much to our knowledge of plant distribution by intensive observations in their own localities.

ROBERT A. EVERS,
ILLINOIS NATURAL HISTORY SURVEY, URBANA.

PODOPHYLLUM PELTATUM F. DEAMII FROM BRYAN COUNTY, OKLAHOMA — The rare, pink-flowered, maroon-fruited *P. peltatum* f. *Deamii* was first described by Raymond (A red fruited form of *Podophyllum peltatum*. Rhodora **50**:18. 1948) from cultivated material grown from seeds obtained from Indiana. Subsequently, it was reported from near Jefferson City, Missouri by Steyermark (Color-forms of the may-apple. Rhodora **54**:131-134. 1952), and from near Chicago, Illinois by Steyermark and Swink (Plants new to Illinois and to the Chicago Region. Rhodora **61**:24. 1959). We have collected this form from two locations in Bryan Co., Oklahoma. Flowering material was collected 1¼ mi. E., 2 mi. N. of Cade along Shawnee Creek on April 6, 1963 *(J. & C. Taylor 1299)*. Later trips were made to the area to check fruit color which proved to be maroon. Fruiting material was collected ½ mi. N. of Armstrong along Blue River on May 6, 1963 *(J. & C. Taylor 1640)*. At the Shawnee Creek site, many stands were located in a dense bottomland forest. The Blue River site also is in a very moist bottomland forest on the floodplain of Blue River, but only a few stands were encountered here. The typical form of *P. peltatum* occurred nearby in abundance at both sites. To the best of our knowledge, these specimens constitute the fourth report of this pink-flowered, maroon-fruited form from the continental United States and is the westernmost and southernmost record for it. The cited specimens are deposited in the Bebb Herbarium, University of Oklahoma, Norman, Oklahoma, and a duplicate *(1299)* is deposited in the herbarium at the New York Botanical Garden.

CONSTANCE AND JOHN TAYLOR,
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ON THE PERIANTH AND SEED CHARACTERS OF CHENOPODIUM HYBRIDUM AND C. GIGANTOSPERMUM

A. I. Baranov

In the course of identifying a collection of Chinese plants, the writer noticed that the Chinese specimens of *Chenopodium hybridum* L. have fruit with the surface structure different from that of European plants. To investigate this difference the writer has made critical comparisons of Asiatic, European, and American specimens of this species in the broad sense, as it is represented in the collections of the Arnold Arboretum and Gray Herbarium. The comparisons were made with special regard to three characters: 1) form of the leaf, especially of the base, 2) structure of perianth, 3) structure of the seed surface. This last character was studied most carefully as it is a very important one in the taxonomy of Chenopodia. Together with the examination of herbarium material the appropriate literature also was consulted.

With regard to the form of the leaf, this study showed that there are no significant differences among the plants of the three geographic areas (cf. Figs. 1 a,b, 2 a,b, 3 a, and 4 a). Wahl (p. 16, 1954), however, says that the American plants have "leaves rounded, truncate or slightly cordate at base . . . " and the European "leaves truncate-cordate at base . . . " The writer could not perceive this fine difference. It may be noted that the European specimens sometimes have leaves with somewhat rounded lobes, while the Asiatic ones always have their lobes strongly and acutely pointed.

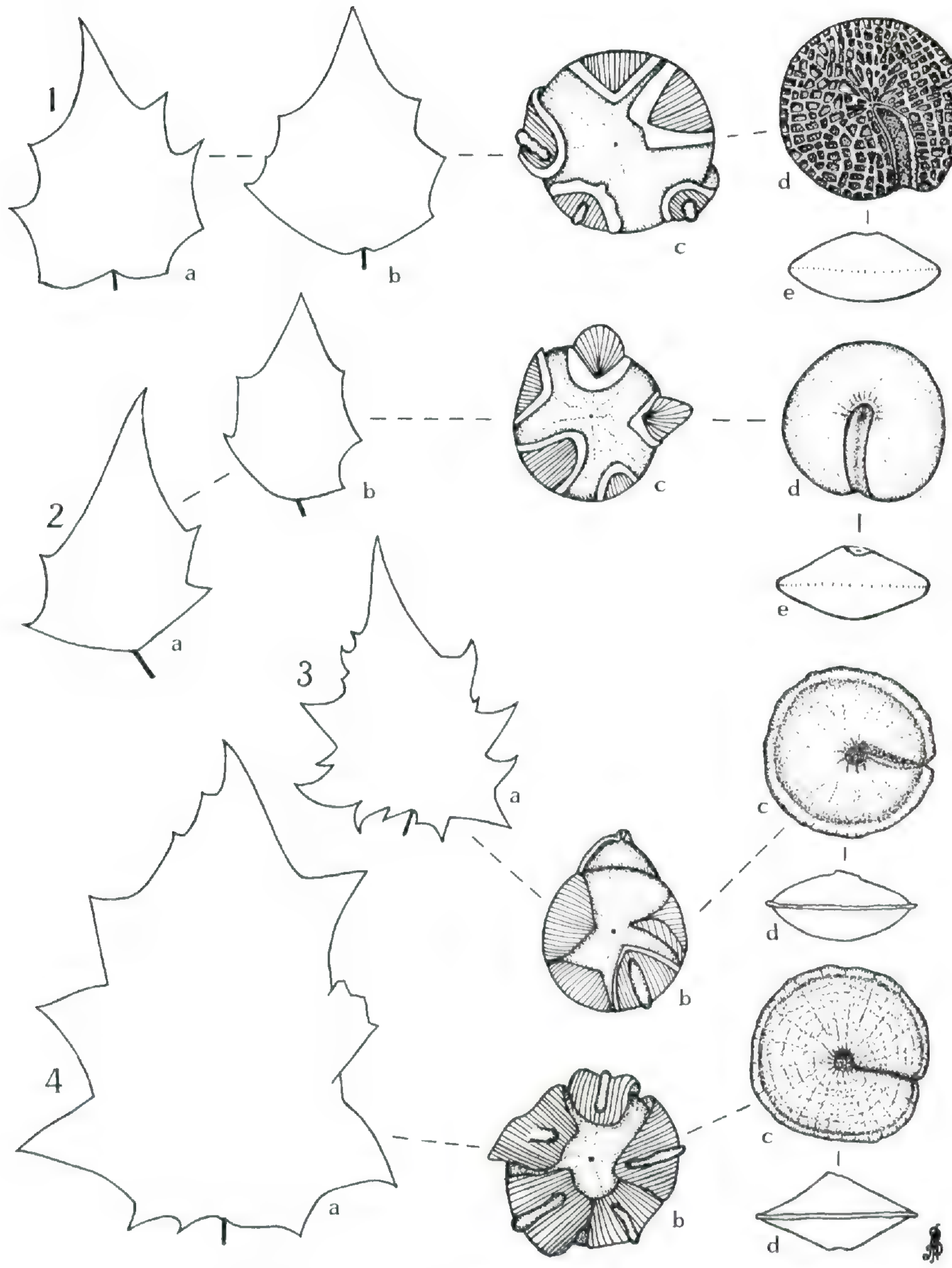
A review of the structure of the perianth gave more interesting results. Both American and European plants have sepals with a definite white margin and green center. The sepals are a little narrower and more distant from each other in American specimens than in European ones (cf. Figs. 1 c, 2 c). However, the writer has not observed the

sharp difference between these groups of plants as described by Wahl (p. 16, 1954). He says, of European plants, "Sepals ovate, their edges meeting to overlapping, covering at least more than half of the mature fruit . . ." and of American plants "Sepals ovate to broadly linear their margins meeting or separated by as much as their width and exposing more than half of the mature fruit . . ." An unexpected, striking difference in this character was found in Asiatic plants. The specimens from China and Mongolia have very broad sepals with meeting and overlapping margins, nearly covering the entire fruit. In addition, the sepals are without white margins or rarely have them weakly developed.

The seeds of each of the three groups of plants are very distinctive, except in size which ranges from 1.5 to 2.5 mm. in diameter. The European material, from which the species was described, has the seeds (Fig. 1 d,e) more or less convex-lenticular, sometimes obliquely lenticular, with rounded margins, black, glossy or dull, more or less definitely foveolate-reticulate, often with the remnants of pericarp in the pits. This description corresponds to that of Hegi (1909-12) and Iljin (1936), although the former says that the seeds are glossy and the latter that they are dull. In fact, both glossy and dull seeds occur among the European plants.

The American material has seeds of a different kind (Figs. 2 d,e). These are sometimes strongly convex- lenticular, always bluntly keeled at the margin, black, glossy, smooth, except for minute radial wrinkles, with readily separable pericarp. The writer has not seen any umbonate-lenticular seeds with sharply defined margin as described by Wahl (1954).

The Asiatic plants have seeds of two kinds. Seeds of plants from the Amur River and Mongolia are close to the European type (Figs. 4 c,d). They are indistinctly foveolate-reticulate and sometimes have a sort of rim along the margin. The plants from northern China probably also belong to this group. The seeds of the plants from southern China (Figs. 3 c,d) are very convex-lenticular with the umbo in the center and a rim at the margin. They are black,



Figs. 1-4. Semidiagrammatic figures of leaves, fruits and seeds of *Chenopodium* species. (Leaves, × ca. ½; fruits and seeds × ca. 10). 1, *Chenopodium hybridum* from Europe: a, b, leaf outlines (a, Flora Carpatica, *C. Branesik* [GH]; b, France, *F. Roux 120* [GH]; c, top view of fruit with perianth; d, top view of seed; e, side view of seed (c-e, Flora exicc. Reipubl. Chechoslov. No. 1323, *F. Svestka* [A]). 2, *Chenopodium gigantospermum* from North America: a, b, leaf outlines (a, Canada, *Edith Scamman 3368* [GH]; b, USA, *F. Lindheimer*

glossy, smooth, except for minute radial wrinkles and grooves. Consequently, they are nearest to the American type.

This study of *Chenopodium hybridum* L. *sensu lato* from Europe, Asia, and America demonstrates that this species may be divided into three taxa. The American plants have been separated from the European ones as *C. gigantospermum* Aellen (*C. hybridum* L. var. *gigantospermum* (Aellen) Rouleau) ; they might be better treated as a subspecies. The Asiatic plants, however, have not been distinguished from the European ones. This perhaps is due to insufficient study of the Asiatic material and inadequate comparison of it with the European, for example, as in the *Flore illustrée du Nord de la Chine* (Kung, 1935).

Although the writer has noted the perianth and seed characteristics that distinguish the Asiatic plants of *Chenopodium hybridum* L. from those of Europe he has not proposed new taxa because of the limited material available for this study.

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Literature Cited

Hegi, G. Illustrierte Flora von Mittel-Europa **3**:1-607. Muenchen. 1909-1912 (Chenopodiaceae pp. 210-260).

Iljin, M. Chenopodiaceae. Flora URSS **6**:1-954. Moscow-Leningrad. 1936.

Kung, Hsien Wu. Amaranthaceae, Chenopodiaceae, Phytolaccaceae & Portulacaceae. Flore illustrée du Nord de la Chine **4**:1-107. Peiping . 1935 (Chenopodiaceae pp. 29-96).

Wahl, H. A. A preliminary study of the genus *Chenopodium* in North America. Bartonia **27**:1-46. 1954

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515 [GH]); c, top view of fruit with perianth; d, top view of seed; e, side view of seed (c-e USA, *Wahl & Niering 8288* [GH]). 3, *Chenopodium hybridum* from South and Western China: a, leaf outline (Western China, Kansu, *R. C. Ching 274* [GH]); b, top view of fruit with perianth; c, top view of seed; d, side view of seed (b, South China, Yunnan, *C. W. Wang 70223* [A]; c-d, *idem, C. W. Wang 70320* [A]). 4, *Chenopodium hybridum* from Mongolia: a, leaf outline (Kalgan, *C. W. Wang 62147* [A]); b, top view of fruit with perianth; c, top view of seed, d, side view of seed (b, Central Mongolia, *N. & V. Ikonnikov-Galitzky 4061* [GH]; c-d, Kalgan, *C. W. Wang 62147* [A]).

PLANT PRESSING WITH PLASTIC SPONGES — There has been little change in the basic method of preserving plant material for herbarium specimens since plants were first dried and pressed between sheets of paper. There have, however, been changes in techniques as materials have become available which have made possible quicker or more satisfactory drying with a consequent improvement in the resulting specimens. There is a satisfaction in fine herbarium specimens not only from the esthetic and craftsman's point of view in presenting the nearest possible approximation to the living plant but also for the plant scientist, enabling him to make examinations and accurate appraisals that are often difficult or impossible with poorly preserved material.

Rapid drying has always been regarded as desirable to hold to a minimum changes in the plant tissues and forestall the action of bacteria and fungi in destroying them. The use of newsprint and driers of blotting paper ordinarily served this purpose well with many plants, but under difficult field conditions the resulting specimens left much to be desired. The first real improvement came in the years just previous to 1910 as J. Franklin Collins reported to the members of the New England Botanical Club (Rhodora **12**:221-224) that he, as well as Professors M. L. Fernald and K. M. Wiegand and others, had been using corrugated cardboard as ventilators in their plant presses. They all reported that the use of the corrugated cardboard speeded the drying process and improved the quality of the finished specimens. These collectors varied considerably in their use of these ventilators especially in the frequency with which they inserted them in building their presses and in whether or not the cardboard was smooth-faced on one or both sides.

The use of ventilators with both faces smooth and with the corrugations running crosswise rather than longitudinally does not seem to have been generally accepted until after 1918 when George E. Nichols and Harold St. John (Rhodora **20**:153-160) pointed out the advantages of such ventilators. The use of these ventilators and insertion next to each drier is now standard procedure. The problem of thick and bulky

specimens continued to plague botanists and they resorted to various paddings of paper and cotton-wool to fill spaces next to thick structures and to level out the press.

In 1960 Jennie V. A. Dieterle (Rhodora **62**:322-324) described a method of holding bulky specimens firmly and uniformly against herbarium sheets while glueing them in place. This entailed the use of large sand bags which pressed all parts of the specimen flat against the sheet while the glue dried. This procedure tested at the University of Michigan has been in use at Kew Herbarium in England for years. The sand bags suggested the idea of pressing bulky specimens in this way in the first place but in some manner that would eliminate the cumbersome sandbags.

Plastic sponges seemed to offer a material that would fit around thick stems and other parts and would press and flatten bulky material without crushing. A number of synthetic sponges were tried by using them in an ordinary plant press in place of one of the driers. One sponge distributed by Magla Products, Inc., 412 Halsey Street, Newark 2, New Jersey seemed to have the requisite qualities of compressibility and recovery along with moisture absorption. A quantity of this sponge material was ordered cut in sheets 18″ x 12″ x 1″ to fit a standard plant press. Trial of these sheets since the fall of 1962 has given remarkably good results on many "hard to press" materials where great variability of thickness of the specimen would ordinarily give indifferent to poor results. The most striking results are possibly with branches of deciduous woody plants having leaves, fruits, flowers or nuts. Thin leaves and delicate floral parts can be pressed perfectly even if adjacent to thick stems, and firm berries are not crushed but flattened only on the underside. The procedure has been to lay out the specimen in the usual manner on, but not between, the folds of newsprint which overlays the usual drier and ventilator (See plate 1297). The sheet of sponge is applied directly on top of the plant material and in case of recalcitrant specimens it may be rolled on from one end while arranging leaves, etc. Once in contact with the sponge surface the plants rarely move. A ventila-

Plate 1297

Press assembly showing a plastic sponge with standard plant pressing equipment. Note that the sponge is applied directly on the specimen.

tor is applied over the sponge and the press built up in this order. Of course, a press assumes gigantic height before being strapped down and about 20 to 25 sheets are all one should attempt in a single press. Care should be taken to build the press evenly and to tighten the straps alternately. Changing the underlying newsprint and drier and even the ventilators will speed the drying process as in any pressing procedure. However, just releasing the press at intervals and allowing the sponges to expand will give considerable ventilation and assist greatly in the drying. Many observers feel that the use of these sponges gives better color preservation than is usually achieved. The greatest advantage is undoubtedly the fact that all parts are evenly pressed against the flat surface of the drier and ventilator without the thicker parts being crushed or the thin and delicate ones underpressed or left in a void.

Material pressed in this manner mounts on the herbarium sheet with ease and if the glue method of mounting is used the sponge plus a weight can be used until the glue has dried if care is taken to remove surplus glue before leaving for any length of time. Filmy and delicate specimens such as some ferns, violets, aquatic plants, grasses, etc., can be mounted with the aid of these sponges. The specimens to be mounted should be arranged in mirror position unside down on the sponge. The herbarium sheet is then entirely covered with dilute glue and applied to the specimens on the sponge in the manner of printing or lithographing thus transferring the flimsy specimens to the mounting paper exactly as arranged on the sponge. Surplus glue can be romoved from the herbarium sheet by blotting with an extra sponge. The sponges wash easily and still retain their original texture. If heat is used to speed the drying as many botanists do with the aid of various heat sources these sponges remain uninjured at any heats ordinarily used. This material has been autoclaved at 15 lbs. for 30 minutes without apparent change in texture or springyness.

After two seasons of fairly continuous use in both field and herbarium these sponges show almost no signs of wear

and tear. Repeated heavy compression over bulky and rough specimens has not permanently deformed or distorted their dimensions. When soiled with plant juices, nectar or other exudates they are easily washed and dried, regaining their original appearance and texture.

The accompanying illustration shows the use of one of the plastic sponge sheets on a specimen of *Ilex verticillata* along with driers, ventilators, wooden press frames, and web straps. On occasion, a third strap may be found desirable if the material being pressed is particularly rough and bulky. Next to the press is a fruiting specimen of American Beech (*Fagus grandifolia*). As can be seen the leaves were pressed and the stem flattened without crushing the burrs or nuts, a result almost impossible by any other method. In case of large diameter stems or fruits as in the hickorys or pines, the thickness of two sponges may be necessary.

Probably the dimensions of future sponges should be 11″ x 17″ x 1″ so that when compressed the edges will not squeeze over the ventilating holes in the corrugated cardbord. This plastic sponge material seems to be as much of an improvement for the pressing of certain types of specimens as the use of corrugated cardboard was for all botanical herbarium specimens fifty years ago.

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A SYSTEMATIC STUDY OF THE GENUS BAHIA (COMPOSITAE)[1]

WILLIAM L. ELLISON

GENERIC RELATIONSHIPS

An introduction to the problem of generic relationships was given in the chapter on taxonomic history. The first serious attempts to ascertain the generic interrelationships between *Bahia*, *Schkuhria*, and *Eriophyllum* were made by Gray (1849, 1884). More recently, Constance (1937) has given attention to the distinctions between *Bahia* and *Eriophyllum*, and Heiser (1945) has briefly discussed the intergeneric problem of *Bahia* and *Schkuhria*.

Whereas biochemical studies will undoubtedly prove to be significant in indicating the relationship between *Eriophyllum* and *Bahia*, morphological characters together with chromosomal information and geographic distribution are sufficiently distinct that the recognition of them as two genera is clearly justified.

The problem of *Bahia* and *Schkuhria* has not been so well resolved. Heiser (1945) recognized the difficulty quite fully and indicated the need of additional study "when more specimens of *Bahia* are available." I am in accord with his inclusion of the taxon *Schkuhria multiflora*[7] in *Schkuhria* rather than in *Bahia*, although additional evidence should be accumulated to support this conclusion.

S. multiflora is an erect annual with opposite leaves and it occurs for the most part in moist habitats at high elevations. In these respects it resembles "true" *Schkuhria* as represented by *S. pinnata*, etc. Certainly the most conspicuous character indicating the affinity of the species to *Schkuhria* is the fact that it is discoid. *S. multiflora* does not have keeled bracts as do species of "true" *Schkuhria*, but rather they usually are cupped and partially enclose peripheral

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[1]Continued from page 86 (Jan.-March 1964).

[7]The North American element of this species has been known as *Bahia neomexicana* Gray (Proc. Am. Acad. 19:27. 1883).

achenes in a manner not commonly found in *Bahia*. Petaloid margins on the bracts, consistently found in *S. multiflora*, are more characteristic of *Schkuhria* than of *Bahia*. Shinners (1951) considered the floral morphology of *S. multiflora* to be more like that of *Bahia* but I do not find the total comparative evidence to be so compelling.

Schkuhria multiflora showed a distinct departure from all species of *Bahia* with respect to the time of meiosis in pollen mother cells. Meiosis occurs at an early stage of bud development in species of *Bahia*, but it takes place at an exceptionally juvenile stage in *Schkuhria multiflora*, as it does also in species of "true" *Schkuhria*. Although no detailed studies of comparative chromosome morphology were conducted, it should be noted that the meiotic chromosome morphology of *S. multiflora* is more like that found in species of *Schkuhria* than of *Bahia*.

Rydberg (1941) included the following genera in the subtribe Bahianae: *Loxothysanus, Picradeniopsis, Bahia, Platyschkuhria, Hulsea, Amauriopsis, Vasquezia, Galeana* and *Achyropappus*. Although the present study does not concern the subtribe as such, some consideration of it seems desirable on the basis of present information. According to Turner (1962), it is likely that *Loxothysanus* belongs to the Eupatorieae; *Hulsea* shows characters suggestive of the tribe Senecioneae (Turner, personal communication). Turner (1962) further suggests that *Hymenothrix, Florestina* and *Schkuhria* (including *Tetracarpum* and *Cephalobembix*) of Rydberg's *Hymenopappanae* be placed, at least tentatively, in the subtribe Bahianeae. In the present treatment *Picradeniopsis* and *Amauriopsis* have been submerged in the genus *Bahia*. As reconstituted along the lines suggested by Turner, the subtribe Bahianeae would consist of the following genera: *Achyropappus, Bahia, Florestina, Galeana, Hymenothrix, Platyschkuhria, Schkuhria* and *Vasquezia*.

Some attention needs to be called to the submergence of both *Picradeniopsis* and *Amauriopsis* in *Bahia*. Rydberg (1914) distinguished *Picradeniopsis* as a genus (of two species) on the following morphological bases: campanulate

involucre, keeled bracts and conspicuously impressed-punctate foliage. Both of the species in the genus are characterized by these features; however, their leaf shape and particularly their floral morphology indicate a close affinity to *Bahia*. Chromatographic evidence on *B. woodhousei (Picradeniopsis woodhousei)* reveals it to be quite distinctive. Chromosomal data and additional chromatographic information are needed. Future study may indicate Rydberg's treatment to be the more natural.

The monotypic genus *Amauriopsis* Rydberg was distinguished by him on the basis of the length of the disc corolla lobes plus the absence of a pappus. Pappus scales occur occasionally in the species, however, and total morphology suggests that it be included in *Bahia* as circumscribed in this study. Chromatographic evidence supports this view, and the chromosome number, although different from all others in the genus, offers no obstacle to the possible origin of *B. dissecta (Amauriopsis dissecta)* from a common ancestral complex for the genus *Bahia* (see the chapter on chromosomal studies).

Rydberg (1914) separated the perennial taxa with woody caudices and alternate leaves of Gray's *Bahia* into a separate genus, *Platyschkuhria*. This genus seems quite properly placed in the Bahianeae, and it is obviously close to *Bahia*. However, I believe that present evidence indicates Rydberg to have been correct in his judgment. Not only does *Platyschkuhria* differ from *Bahia* in its habit, root and leaf character, but also in certain floral features; e.g., there are no species of *Bahia* with cylindro-campanulate corollas. A single chromosome count of $n = 12$ has been reported by Raven and Kyhos (1961). This accords with not only *Bahia* but with *Florestina* and *Hymenothrix* as well. A critical study of the genus is needed in order to properly assess its relationship in the subtribe.

DISTRIBUTION AND ECOLOGY

Bahia, as circumscribed in the present treatment, is bicentric in distribution. Only one taxon (the type species, *B. ambrosioides*) is found in South America (Chile), while

all others occur in central and northern Mexico and in the southwestern and western United States. The South American species, belonging to series Oppositifoliae, is found in coastal regions, although it exhibits xerophytism, as do some of its North American counterparts. Members of the series Alternifoliae occupy, for the most part, relatively mesic

Fig. 40. Map showing distribution of the genus *Bahia*.

habitats at high elevations. Within this series, however, there is a trend toward xerophytism at lower elevations as demonstrated by *B. autumnalis*. Species of the series Oppositifoliae occur in both mesic and xeric habitats. *Bahia oppositifolia* and *B. woodhousei* are closely related perennial, grassland species which are widely distributed from Montana to central New Mexico. Whereas both annual and perennial species of western Texas and central Mexico occur in more localized mesic habitats, obviously closely related taxa show increased adaptation to more xeric conditions at lower elevations. Of the two xerophilous species of series Oppositifoliae, *B. absinthifolia* and *B. schaffneri*, the former is widespread, occurring from western Texas to southcentral Mexico while the latter is restricted to a small area in central Mexico. With the exception of but two taxa, *B. bigelovii* and *B. dissecta*, all species of *Bahia* occur in open, sunny habitats. Edaphically, the species of *Bahia* are most prevalently found in calcareous soils, although they are commonly encountered in sandy loams of igneous derivation. Some of the taxa are frequently found in more than one soil type. More specific ecological observations are given under the various species in the taxonomic section.

PHYLOGENETIC SPECULATIONS

There are many individuals who disdain phylogenetic speculations which are not founded upon paleobotanical evidence. I am of the opinion, however, that such speculations are worthwhile in that they stimulate further thought and focus attention on problems of relationship that might not be evident from a more standard treatment.

In order to present a plausible evolutionary history of a genus, the reconstruction of a probable ancestral stock is expedient, if not necessary. Small (1919) and Cronquist (1955), among others, have offered various primitive characters for the family Compositae. I shall make no attempt in the present study to defend the logic of the primitiveness of the various characters as hypothesized below. The interested reader is referred to the aforementioned papers of Small and Cronquist. If one applies the ideas propounded by

them, in addition to chromosomal information, to the genus *Bahia*, the following contrasted list of primitive versus advanced characters may be obtained:

1. Chromosome number of $n = 8$ as opposed to numbers of a higher order;
2. Perennial as opposed to biennial or annual habit;
3. Herbaceous as opposed to woody stems;
4. Many-flowered as opposed to few-flowered heads;
5. Yellow as opposed to white ray flowers;
6. Pubescent as opposed to glabrous achenes;
7. Pappose as opposed to epappose achenes;
8. Entire as opposed to dissected leaves;
9. Opposite as opposed to alternate leaves;
10. Numerous as opposed to few ray flowers.

In the series Alternifoliae, 4 to 6 of the primitive attributes are found in each taxon. Six to 8 of these attributes are found in the various taxa of the series Oppositifoliae with *B. absinthifolia*, *B. pringlei*, *B. woodhousei* and *B. xylopoda* each having 8 of them. Thus, no single extant species can be considered as *the* primitive taxon. It seems probable that all of the phylads are of long standing, probably having been derived from a mesophytic progenitor.

Hypothetical natural relationships in *Bahia*, based principally upon comparative morphology, chromosome numbers, and chromatographic data, are shown in Fig. 41. Within any one series, the gaps between the taxa indicate relative divergence.

SPECIFIC CONCEPTS

An attempt has been made to delimit the natural units of *Bahia* by combining all available morphological, cytological, biochemical and ecological information. The term *species* is used for those natural entities which can be recognized readily and delimited adequately on the basis of this information. Under this concept a species is a systematic category comprising 1 or more individuals which, on a populational basis, fall within relatively discrete units, the parameters of which can be adequately circumscribed by both qualitative and quantitative features. Varietal status has been accorded those natural populations demonstrating a total similarity greater than that found at the inter-specific level, but which

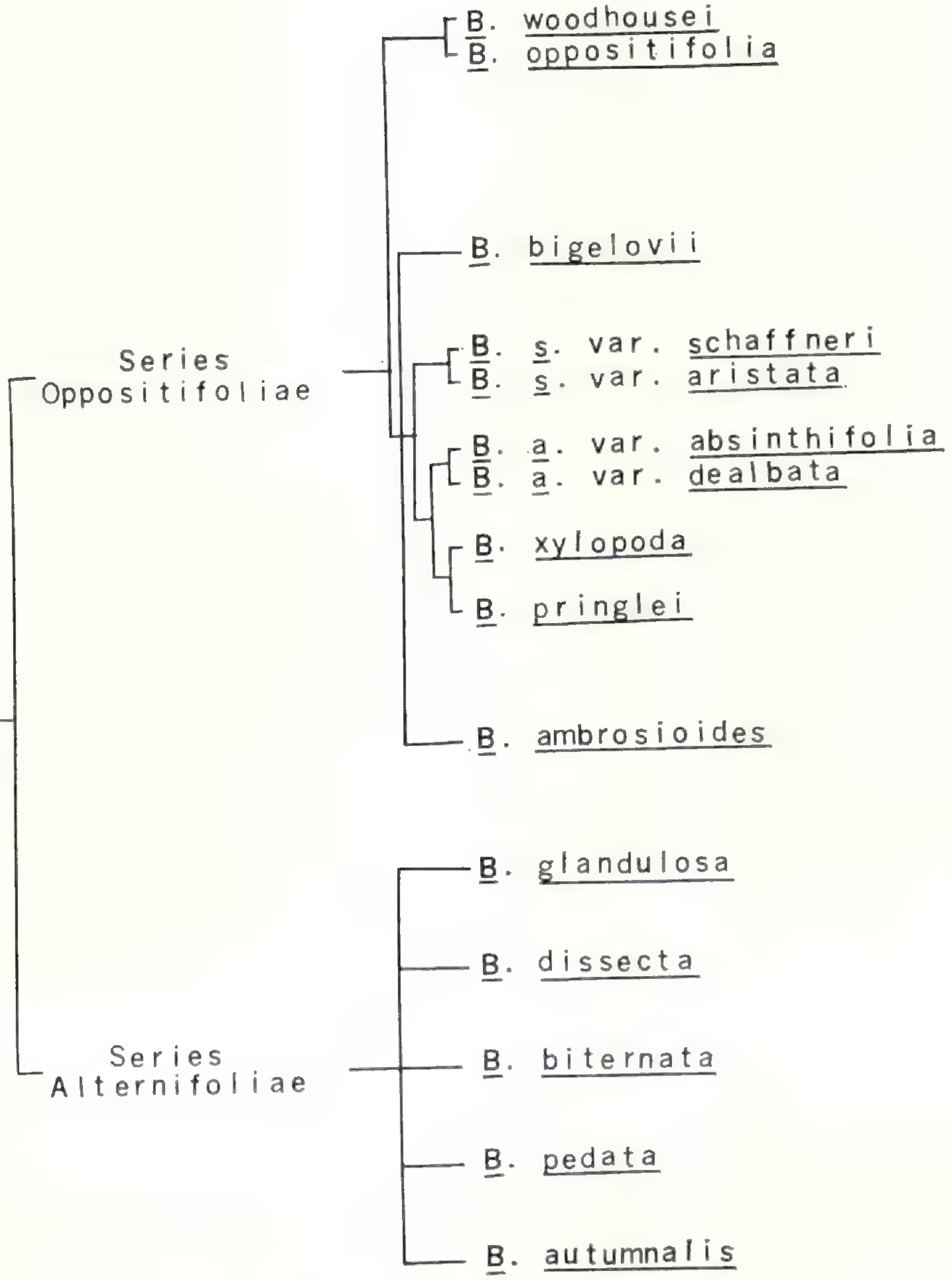

Fig. 41. Hypothetical relationships in *Bahia*. Gaps between taxa indicate relative divergence (additional explanation in text).

are recognizable by one to few characters and often only on a statistical basis. These populations are geographically coherent but often intergrade with peripheral related taxa. Thus, the recognition of varieties in the present treatment is comparable to that of the subspecies of many workers and is determined largely by relative differences and or similarities among the taxa treated. Throughout this study there has been a concerted attempt to maintain a conservative approach and to treat the various taxa consistently with respect to their recognition as species or variety.

ACKNOWLEDGEMENTS

The author is particularly indebted to Dr. B. L. Turner for his suggestion of the problem and his untiring guidance and interest. Equivalent thanks are due my wife for her active cooperation. Appreciation is likewise expressed to Dr. R. E. Alston for his critical appraisal of the chromatographic work; to Mr. Geza Knipfer, Mrs. Karin Douthit, Mr. Paul Sun and Mr. Alexandri Garcia for various services rendered; to Drs. M. C. Johnston and Bill Cumbie for plant and bud collections; and to Drs. Lincoln Constance and W. V. Brown for critical reading of the manuscript.

A list of herbaria consulted in this study follows. The abbreviations used in the citations of the specimens are those recommended by Lanjouw and Stafleu (1956). Grateful acknowledgment is made to the curators of the herbaria for the loan of the specimens.

ARIZ University of Arizona; CAS California Academy of Sciences; DS Dudley Herbarium, Stanford University; F Chicago Natural History Museum; GH Gray Herbarium, Harvard University; LL Lundell Herbarium, Texas Research Foundation; MICH University of Michigan; PH Academy of Natural Sciences, Philadelphia; TEX University of Texas; UC University of California, Berkeley; US United States National Herbarium.

SYSTEMATIC TREATMENT

Bahia Lag., Gen. et Sp. Nov. 30, 1816.

Stylesia Nutt., Trans. Am. Phil. Soc., Ser. II, 7:377. 1841. Type species: *Bahia ambrosioides* Lag. (Nuttall proposed the generic name

Stylesia for the South American elements and, contrary to the present Code, took up the name *Bahia* for the North American taxa.)

Virletia Schultz-Bip. ex Benth. & Hook., Gen. Pl. 2:403. 1873. (In synonymy).

Picradeniopsis Rydb., in Britton Man. 1008. 1901. Type species: *Trichophyllum oppositifolium* Nutt.

Amauriopsis Rydb., N. Am. Fl. 34:37. 1914. Type species: *Amauria? dissecta* Gray.

Annual, biennial and perennial herbs or undershrubs. Stems herbaceous, erect to decumbent, slender or stout from a taproot (annual and biennial species), or herbaceous to suffruticose, erect and usually highly branched from a woody ramifying rootstock (perennial herbs and undershrubs). Leaves opposite or alternate, mostly ternately dissected into linear or ovate segments (often simple or merely lobed in *B. absinthifolia*), impressed-punctate or puncticulate with a globular exudate. Inflorescence a few- to many-headed cymose panicle. Heads radiate, hemispheric to campanulate on short or elongated slender peduncles. Involucre of 8-24 subequal bracts in 1-3 series, these membranous on the margins, usually reflexing with age. Receptacle naked, flat to slightly convex. Ray florets 5-20, pistillate and fertile with yellow or white ligules. Disc florets 25-140 with regular corollas (often zygomorphic, particularly in peripheral florets), yellow; tube glandular; throat funnelform or broadly campanulate after anthesis; lobes mostly equal, more or less reflexed after anthesis; anthers partially exserted in mature florets, inconspicuously sagittate at the base with an ovate terminal appendage; style branches more or less flattened with stigmatic lines marginal on the inner upper surface, apices obtuse with papillose enlargements, more or less recurved at maturity; achenes 4-sided, narrowly obpyramidal, hispid, glandular or glabrous; pappus of 8-15 scarious obovate or lanceolate scales thickened at the base with the midrib lacking, percurrent or excurrent.

Basic chromosome numbers as determined from meiotic counts on ten of the taxa, $x = 8$, 10, 11, 12, 18 (with tetraploids in the 11 and 12 series plus a hexaploid in the 12 series).

ARTIFICIAL KEY TO TAXA

1. Leaves alternate (opposite or nearly so only at the very base); plants 30-120 cm. tall, the stems single and erect from a root-crown (occasionally 2-3 through injury), 4-15 mm. in diameter. .... Series ALTERNIFOLIAE

2. Ray florets white or pale yellowish-cream; achenes markedly hispid at base, glabrous or nearly so above; vegetative parts (including involucral bracts) markedly stipitate-glandular. .... 1. *B. glandulosa*

2. Ray florets yellow; achenes either glabrous or hispid on all parts (except in *B. autumnalis*); vegetative parts with or without stipitate glands, but when present not on all parts (except in *B. pedata*).

3. Pappus absent or rarely present (when present, the scales distinctly lanceolate); achenes glabrous or inconspicuously hispidulous (sparingly hispidulous when a pappus is present). ..... 2. *B. dissecta*

3. Pappus present, the scales oblanceolate, obovate or spatulate (rarely lanceolate); achenes distinctly hispid.

4. Achenes glabrous on the sides; vegetative parts without stipitate glands; Nuevo León and extreme eastern Coahuila. ..... 3. *B. autumnalis*

4. Achenes hispidulous on all parts; vegetative parts with stipitate glands; New Mexico, Arizona, Chihuahua, and northwestern Coahuila.

5. Pappus scales of inner achenes with a prominent excurrent midrib; leaf segments 1-3 mm. wide; stipitate glands mostly restricted to upper stem. .... 4. *B. biternata*

5. Pappus scales mostly lacking an excurrent midrib (when excurrent, minutely so and throughout the head); leaf segments 2-5 mm. wide; stipitate glands present on all vegetative parts. ..... 5. *B. pedata*

1. Leaves opposite (becoming alternate on upper branches only); plants 5-25 (-100) cm. tall, the stems branched from the base (single and erect in *B. bigelovii*), 1-7 mm. in diameter. .... Series OPPOSITIFOLIAE

6. Suffruticose; ray florets white or cream-colored; South America. ..... 6. *B. ambrosioides*

6. Herbaceous or suffrutescent; ray florets yellow; North America.

7. Plants annual.

8. Stems erect; mountains of western Texas. .... 7. *B. bigelovii*

8. Stems decumbent; plateau of north-central Mexico.

9. Pappus scales without midribs, 0.7-1.5 mm. long. .... 8a. *B. schaffneri* var. *schaffneri*

9. Pappus scales with distinct midribs extending as excur-

rent awns, 1.2-2 mm. long (excluding awn). .....
..... 8b. *B. schaffneri* var. *aristata*

7. Plants perennial.
   10. Upper leaves opposite; ray florets 4-9, the ligules 2-4(6) mm. long; disc florets 25-40.
      11. Achenes glandular; pappus scales ovate or obovate (rarely lanceolate with percurrent or excurrent midribs). ..... 9. *B. oppositifolia*
      11. Achenes hispidulous; pappus scales lanceolate with percurrent or excurrent midribs. ..... 10. *B. woodhousei*
   10. Upper leaves alternate; ray florets 9-15; the ligules 4-9 (-15) mm. long; disc florets 60-120.
      12. Leaves densely white pubescent; pappus scales 6-9; lateral roots not forming adventitious shoots; southwestern United States to central Mexico.
         13. Leaves commonly trifid or dissected, the leaf segments 1-3 mm. wide. .....
         ..... 11a. *B. absinthifolia* var. *absinthifolia*
         13. Leaves commonly entire, toothed or trifid, the leaf segments (1-) 2-15 mm. wide. .....
         ..... 11b. *B. absinthifolia* var. *dealbata*
      12. Leaves sparsely pubescent; pappus scales 8; lateral roots forming adventitious shoots; Hidalgo.
         14. Pappus scale width/length ratio = 0.5-0.7; rootstock 2-5(15) mm. thick; chromosome number, n = 11. ..... 12. *B. xylopoda*
         14. Pappus scale width/length ratio = 0.75-1.2; rootstock 2-4(8) mm. thick; chromosome number, n = 22. ..... 13. *B. pringlei*

Series ALTERNIFOLIAE

1. *Bahia glandulosa* Greenman

Bahia glandulosa Greenman, Proc. Am. Acad. 39:116. 1904. Holotype examined (GH): "Durango and vicinity," Durango, Mexico, April to November, 1896, *E. Palmer 492*. The type collection [the holotype can be only one sheet] is represented by two sheets. Isotypes examined: (F, UC, US).

Hymenopappus glandulopubescens Waterfall, Rhodora 59:97. 1957. Isotype examined (GH): "Grassy flat, 11 miles west of Durango, Durango, Mexico," August 10, 1956, *U. T. Waterfall 12576*. (Holotype: OKLA, not examined).

Plants annual (biennial?), 60-120(-150) cm. tall. Stem single and erect from a tap root (rarely 2 or more stems forming from the root-crown following injury), 4-8 mm. in diameter, paniculately branched, each terminal branch culminating in 1-7 monocephalic peduncles, ribbed, variously pubescent and with numerous stipitate glands, the latter up to 0.8 mm. long; peduncles 1-7 cm. long, sparsely to densely

pubescent and stipitate-glandular. Leaves opposite or nearly so at the extreme base, otherwise alternate, ternately divided, each segment compoundly subdivided into linear or narrowly oblanceolate segments 1-4 mm. wide, upper leaves ternately divided into linear entire segments, 3-14 cm. long, pubescent, blade puncticulate with globules of exudate in the depressions and few to numerous stipitate glands, petiole with numerous stipitate glands. Mature heads (including florets) 4-8 mm. high, 10-17 mm. in diameter. Involucre broadly campanulate; involucral bracts stipitate-glandular, 12-17 in 1-2 series, frequently with 1-2 outer bractlets, reflexing with age, membranous margins occasionally tinged with purple, 3-4.5 mm. long, 1.2-2 mm. wide, obovate or lanceolate, apex obtuse or somewhat acuminate, midrib weakly discernible or absent. Receptacle somewhat convex, alveolate, 2.8-3.2 mm. in diameter. Ray florets 10-25, white or very pale yellowish-cream, pistillate, fertile; ligule 3-6(8) mm. long, 3.5-4.5 mm. wide, obovate with truncate undulate apex; tube 0.2-0.3 mm. in diameter, 1.5-2 mm. long with few to numerous stipitate glands (occasionally almost glabrate). Disc florets 100-140, perfect and fertile, yellow, regular, 2.7-3.3 mm. long; tube and lower throat with few to numerous stipitate glands; tube 0.3-0.4 mm. in diameter, 1.2-1.5 mm. long; throat broadly campanulate, 0.7-1.3 mm. long; lobes 5, reflexed at maturity, 0.4-0.8 mm. long; anthers 1-1.3 mm. long, partially exserted at maturity; style branches flattened, 0.6-0.8 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices obtuse with reduced papillose enlargements; achenes 2-3.8 mm. long, narrowly obpyramidal, 4-sided, dark brown or black, hispid on the angles near the base, the hairs to 0.3 mm. long, glabrous or nearly so on the upper part; pappus of 11-12 scarious obovate-lanceolate scales, 0.5-1 mm. long, 0.2-0.5 mm. wide, thickened at the base with the midrib extending about ½ of the length of the scale. Chromosome number, $n = 12$.

DISTRIBUTION: Clayey or sandy soil of igneous derivation in the states of Aguascalientes, Zacatecas and Durango, Mexico, 6000-7500 ft. (Fig. 42). Principal flowering dates August-October.

B. glandulosa is the only North American taxon of the genus which has white rays. Whereas this could indicate a close affinity to *B. ambrosioides* of South America, which also has white rays, in total morphology *B. glandulosa* is more closely allied to the other four species in the series Alternifoliae than to any other taxon or group of taxa in the genus.

There has been some confusion between *B. glandulosa* and *B. pedata* in a possible region of overlap near the Chihuahua-

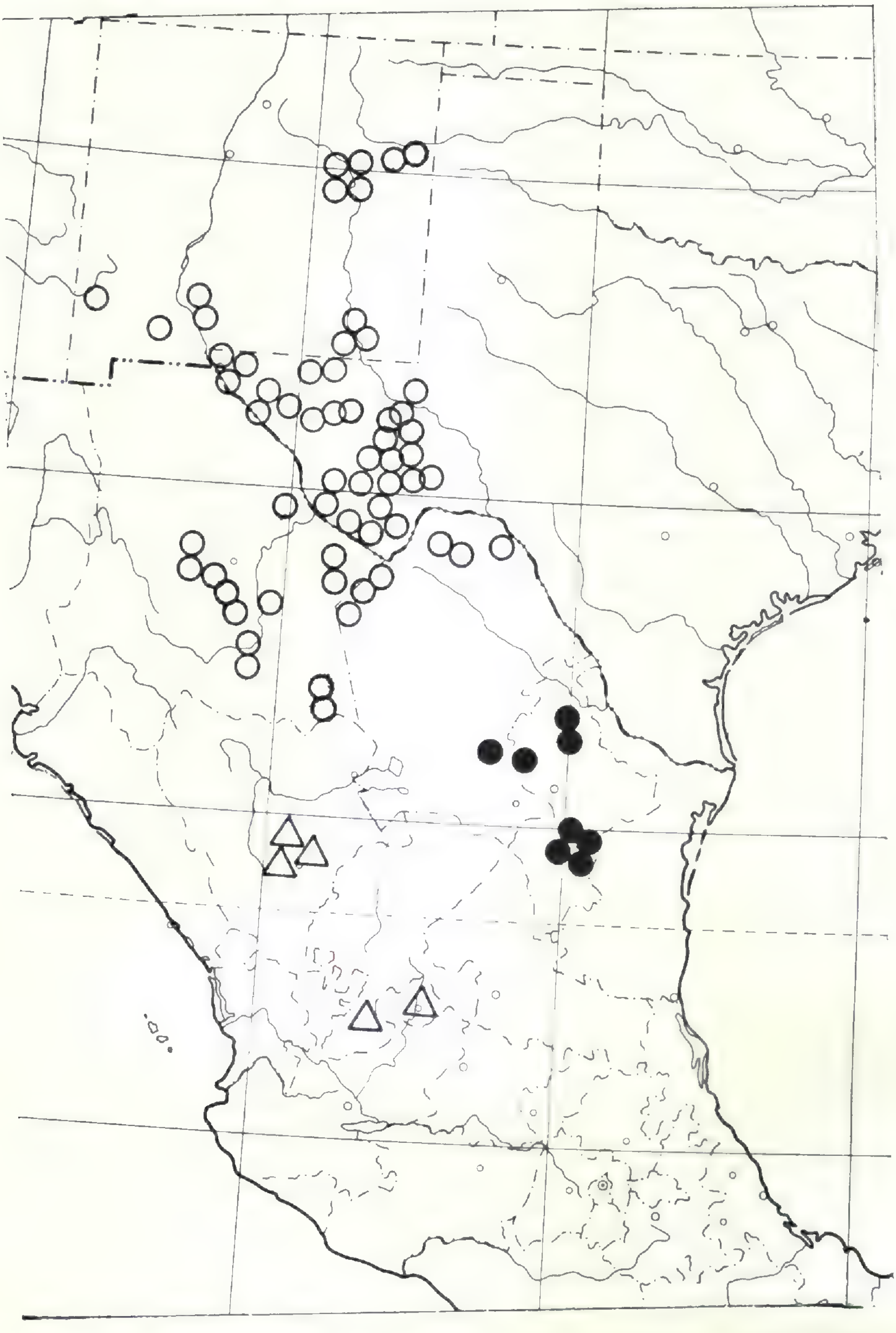

Fig. 42. Map showing distribution of *B. autumnalis*, closed circle; *B. glandulosa*, open triangles; *B. pedata*, open circles.

Durango line. Greenman misidentified plants of *B. pedata* as *B. glandulosa,* these having been collected near Chihuahua *(C. G. Pringle 308,* labeled as *B. biternata);* on the basis of glandulosity and leaf shape the specimens of this collection do bear a superficial resemblance to *B. glandulosa,* but on the basis of total morphology they are properly assigned to *B. pedata.* Field observations of populations of *B. pedata* made by the writer in the vicinity of Parral and Chihuahua, Chihuahua, and northward indicated that only robust yellow-rayed plants referable to *B. pedata* occupied this region. However, the individuals were somewhat more viscid and definitely had more dissected leaves than did those of *B. pedata* at more northerly latitudes. The possibility of hybridization and resultant introgression between the latter taxon and *B. glandulosa* cannot be dismissed. A more intensive populational and cytological study needs to be conducted in order to ascertain the nature of this variation.

SPECIMENS EXAMINED: MEXICO. AGUASCALIENTES: Near Aguascalientes, Oct. 9, 1903, *J. N. Rose & J. H. Painter 7759* (US). DURANGO: 11 miles W. of Durango on Hwy. 40, 7400 ft., Sept. 3, 1960, *W. L. Ellison & A. Garcia 118* (TEX). 23 miles N. of Durango on Hwy. 45, 6300 ft., Sept. 3, 1960, *W. L. Ellison & A. Garcia 125* (TEX). 15 miles S. W. of Durango on Hwy. 40, Aug. 16, 1960, *R. M. King 3737* (TEX). Durango and vicinity, Apr.-Nov., 1896, *E. Palmer 492* (F, GH, UC, US). North base of Cerrito del Santuario, Durango, Oct. 15, 1910, *C. Patoni 94* (F). ZACATECAS: Near Plateado, Sept. 3, 1897, *J. N. Rose 2772* (GH, US).

2. *Bahia dissecta* (Gray) Britton

Amauria? dissecta Gray, Mem. Am. Acad. II. 4:104. 1849. Holotype examined (GH): "A few miles east of Mora River," August, 1847, *A. Fendler 537. Villanova chrysanthemoides* Gray, Pl. Wright. 2:96. 1853. *Bahia chrysanthemoides* (Gray) Gray, Proc. Am. Acad. 19:28. 1883. *Bahia dissecta* (Gray) Britt., Trans. N. Y. Acad. Sci. 8:68. 1888. *Eriophyllum chrysanthemoides* (Gray) Kuntze, Rev. Gen. Pl. 337. 1891. *Villanova dissecta* (Gray) Rydb., Bull. Torr. Club 37:333. 1910. *Amauriopsis dissecta* (Gray) Rydb., N. Am. Fl. 34:37. 1914.

Bahia dissecta (Gray) Britt. var. *anisopappa* Blake, Jour. Wash. Acad. Sci. 6:319. 1935. Holotype examined (US): "Sandy soil along La Sanca Creek, below La Grulla, Sierra San Pedro Martir, alt. 2040 m.," Sept. 17, 1930, *I. L. Wiggins & D. Demaree 4870.* Isotypes examined: (DS, UC).

Plants annual (biennial?), 20-80(-120) cm. tall. Stem single and

Fig. 43. *B. glandulosa* (*Rose 7759*, US). Entire plant, × 2/7. a. Mid-stem leaf, × ca. 2/7. b. Head, × ca. 2. c. Ray floret, × ca. 4. d. Disc floret, × ca. 4. e. Pappus scale, × ca. 18. f. Style branches, × ca. 12.

erect from a taproot (rarely 2-3 stems forming from the root-crown following injury), 2-7 mm. in diameter, paniculately branched, each terminal branch culminating in numerous monocephalic peduncles, ribbed, usually reddish-purple, except the upper branches, farinose, more or less pubescent with numerous stipitate glands on the upper stems and peduncles (rarely peduncles almost tomentose and non-glandular). Leaves commonly in a close spiral arrangement on the lower stem, alternate, ternately divided, each segment compoundly subdivided into linear or oblong-ovate segments 1-3 mm. wide, upper leaves reduced in size and ternately divided into entire linear-lanceolate segments, 2-13 cm. long, more or less pubescent, occasionally farinose (rarely with globules of exudate). Mature heads (including florets) 5-10 mm. high, 10-20 mm. in diameter. Involucre hemispheric or broadly campanulate; involucral bracts pubescent and/or with few to numerous stipitate glands (rarely nearly glabrous), often farinose, globules of exudate numerous or absent, 12-24 in 2-3 series, partially reflexing with age, green or somewhat purplish with membranous margins, 4.5-6 mm. long, 1-3 mm. wide, oblanceolate to lanceolate, apex markedly acuminate, midrib weakly discernible or absent. Receptacle somewhat convex, alveolate, 2-3 mm. in diameter. Ray florets 10-20, yellow, pistillate, fertile; ligule 5-7.5 mm. long, 2-3.5 mm. wide (rarely strongly reduced and/or highly modified; Fig. 46), linear-oblong with apex notched or irregularly lobed; tube 0.3-0.5 mm. in diameter, 1.5-2.5 mm. long with numerous stipitate glands. Disc florets 50-100, perfect and fertile (occasionally pistillate), yellow, regular or distinctly zygomorphic, 2.5-3.5(4.5) mm. long; tube, throat and lobes with numerous stipitate glands; tube 0.3-0.5 mm. in diameter, 1-1.5 mm. long; throat narrowly campanulate or funnelform, (0.4)1-1.5 mm. long; lobes 5, partially reflexed at maturity, 0.3-1(2) mm. long, rarely equal to or longer than the combined tube and throat; anthers 1.6-2 mm. long, only slightly exserted at maturity; style branches flattened, 1-1.5 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices obtuse with a papillose enlargement; achenes 3-4.5 (5) mm. long, narrowly obpyramidal, 4-sided, dark brown or black, hispidulous or nearly glabrous; pappus usually lacking (when present, pappus scales lanceolate, 1-13 in number, 1.5-3(5) mm. long, 0.2-0.4 mm. wide, thickened at the base with the midrib percurrent or excurrent). Chromosome number, $n = 18$.

DISTRIBUTION: Igneous, granitic and sandy alluvial soils in juniper-pine woodlands in mountainous regions of west Texas, New Mexico, Arizona, southern California, Nevada, Wyoming, Colorado, and in northern Baja California, northern Sonora and Chihuahua, Mexico, 5200-9300 ft., (Fig. 44). Principal flowering dates July-October.

Blake described *B. dissecta* var. *anisopappa*, a pappose

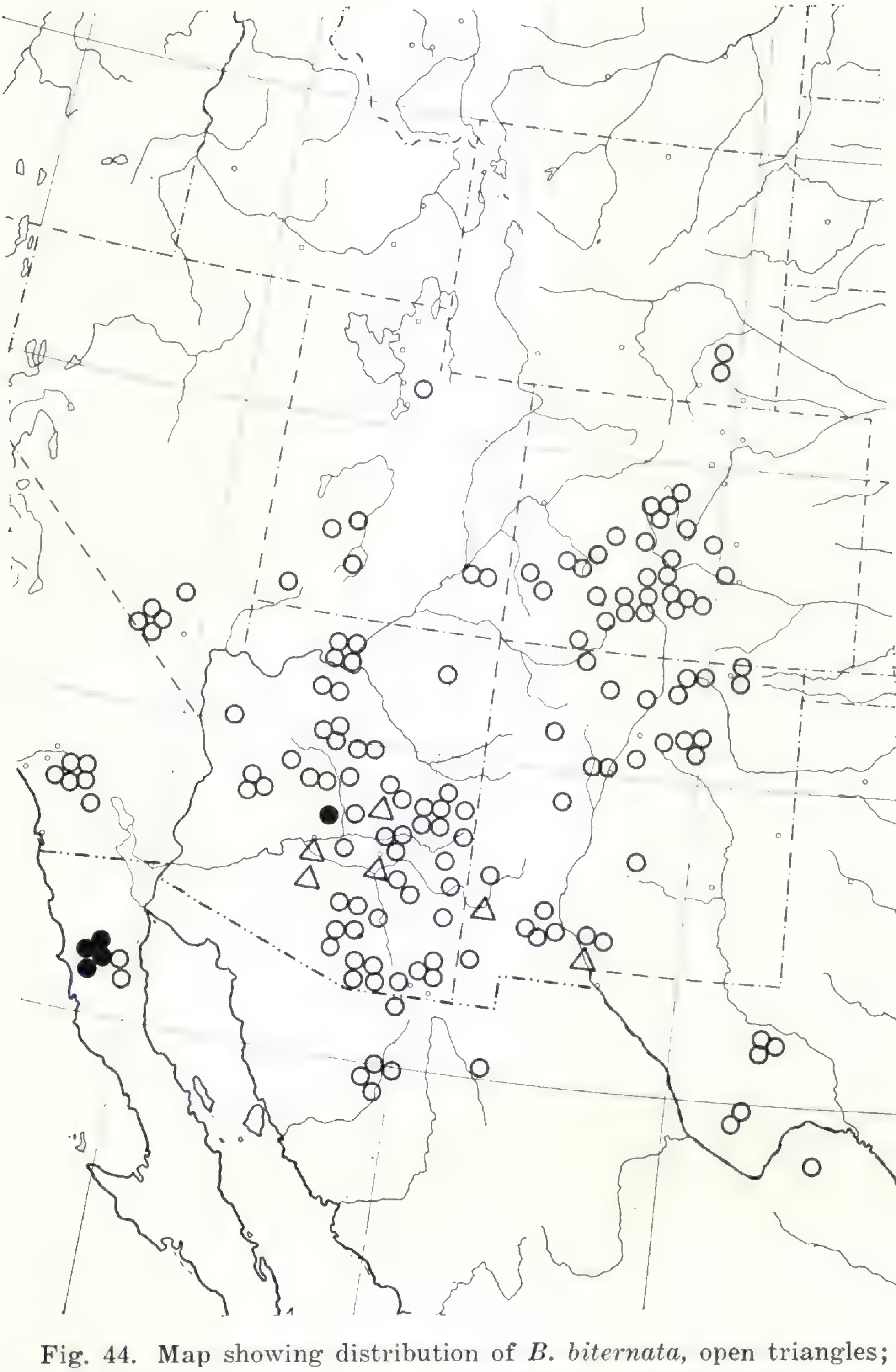

Fig. 44. Map showing distribution of *B. biternata,* open triangles; *B. dissecta,* w/o pappus scales, open circles; *B. dissecta* with pappus scales, closed circles.

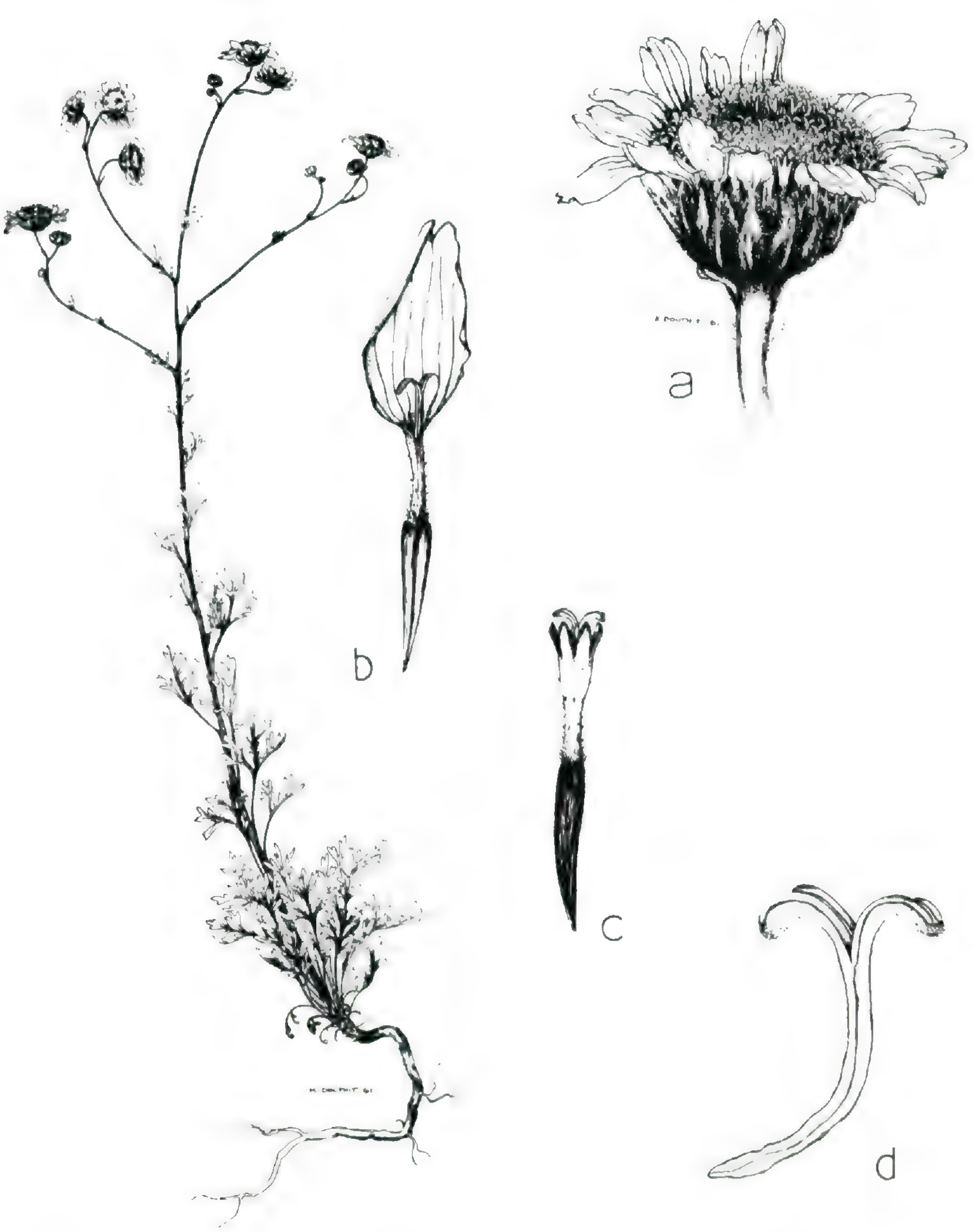

Fig. 45. *B. dissecta* (Holotype, *Fendler 537*, GH). Entire plant, × 2/7. a. Head, × ca. 2. b. Ray floret, × ca. 4. c. Disc floret, × ca. 4. d. Style branches, × ca. 12.

Fig. 46. *B. dissecta* (Holotype of *B. dissecta* var. *anisopappa, Wiggins 4870,* US). Entire plant, × 2/7. a. Head, × ca. 2. b. Ray floret, × ca. 3. c. Disc floret, × ca. 3. d. Pappus scale, × ca. 12. e. Style branches, × ca. 12.

form of *B. dissecta*, as "indistinguishable from typical *B. dissecta* except by its imperfectly and perhaps abnormally disciform heads and more definitely hispidulous achenes." The disciform heads are associated with the pappose form, but pappose forms exist which have normally developed ray florets *(McDougal 701, Wiggins 4886, Wiggins 9081)*. Both pappose and epappose forms are found in Baja California, and these, presumably, in discrete populations. There are apparently no geographical or ecological factors involved in their separation. The pappose condition is variable; that is, there may be no or one or more scales up to a maximum of about 13. This variation may occur to some degree within an individual head or between individuals of a population, as well as between populations. Two specimens of the pappose form were found in localities other than Baja California; namely, one from Pine, Arizona *(McDougal 701)*, the other from Hurrah Creek, New Mexico(?) *(Bigelow s. n.)*.

It is probable that Blake's observation that the presence of "better developed hairs on the achenes of var. *anisopappa* is no doubt correlated here . . . with the development of a pappus" is sound. It has been determined that a single gene may control the presence and absence of both pappus and hairs on an achene (Clausen, 1951). Though this may not apply to *B. dissecta* on any *a priori* basis, it does seem probable that the pappose condition of this species may be influenced by no more than a few genes. Their random segregation would account for the occasional occurrence of the pappose condition in geographically isolated populations. A gene pool favoring the pappose form is presumably present in Baja California. Whereas future populational and cytological studies may indicate a reinstatement of var. *anisopappa*, I think its submergence into *B. dissecta* proper on the basis of total evidence at this time.

In Gray's original description of *Amauria? dissecta*, he indicated that "the stamens are abortive in all the disc flowers." Pistillate disc florets were found in about 5% of the specimens examined. There was no apparent geographical or ecological factor associated with this condition.

Blake makes a point of his having found no specimens fulfilling Gray's description of the lobes of the disc corollas "almost equalling the tube and throat together." Though this condition of elongate lobes is not commonplace, neither is it extremely rare.

REPRESENTATIVE COLLECTIONS: ARIZONA. APACHE CO.: Near Greenlee Co. line on road from Hwy. 260 to Blue, 7900 ft., Sept. 4, 1948, *F. W. Gould & M. E. Robinson 5135* (ARIZ, UC). COCHISE CO.: Chiricahua Nat'l. Forest, Paradise, 2200 m., Sept. 23, 1914, *W. W. Eggleston 10861* (GH, US). COCONINO CO.: Flagstaff, Aug. 29, 1884, *M. E. Jones 4100* (ARIZ, CAS, DS, F, US). Pine Creek, Pine, Aug. 26, 1891, *D. T. McDougal 701* (US). GILA CO.: Sierra Ancha Mts., Workman Creek area, Peterson Ranch, 7000 ft., Aug. 31, 1946, *F. W. Gould & R. K. Hudson 3769* (ARIZ, GH, UC). GRAHAM CO.: Pinaleno Mts., Hospital Flats, 8500 ft., Sept. 4, 1944, *R. A. Darrow, W. S. Phillips & L. M. Pultz 1165* (CAS, DS, LL). GREENLEE CO.: 45 miles N. of Clifton, White Mts., 8100 ft., Aug. 11, 1935, *T. H. Kearney & R. H. Peebles 12254* (ARIZ, GH). MOHAVE CO.: Hualpai Mt., 5100 ft., Sept. 19, 1935, *T. H. Kearney & R. H. Peebles 12666* (ARIZ). NAVAJO CO.: Black Mesa, Sept. 13, 1938, *A. Eastwood & J. T. Howell 6627* (CAS). PIMA CO.: Rincon Mts., 7400 ft., Sept. 9, 1909, *J. C. Blumer 3595* (ARIZ, DS, F, GH). SANTA CRUZ CO.: Santa Rita Mts., 6000 ft., Sept. 30, 1944, *F. W. Gould 2629* (ARIZ, UC). YAVAPAI CO.: Near Prescott, Nov. 11, 1928, *A. Eastwood 16824* (CAS). CALIFORNIA. RIVERSIDE CO.: Santa Rosa Mts., ridge E. of Toro Peak, 8000 ft., Aug. 14, 1938, *P. A. Munz 15364* (CAS). SAN BERNARDINO CO.: San Bernardino Mts., Santa Ana River, 6600 ft., Aug. 21, 1922, *P. A. Munz 6130* (CAS, DS, UC). COLORADO. ARAPAHOE CO.: Denver, along Platte R., 5200 ft., Aug. 27, 1918, *I. W. Clokey 3246* (CAS, DS, TEX). ARCHULETA CO.: 5 miles W. of Pagosa Springs, Aug. 10, 1937, *M. Ownbey 1429* (UC). BOULDER CO.: 0.5 miles below Jamestown, above Boulder, 7500 ft., July 14, 1941, *J. A. Ewan 13345* (CAS, GH). CLEAR CREEK CO.: Near Empire, 9000 ft., Aug. & Sept., 1892, *H. N. Patterson 223* (F, GH, MICH, US). CONEJOS CO.: 0.5 miles S. of Rito Hondo Creek, 2 miles S. W. of Bighorn Corral, 8500 ft., Aug. 3, 1936, *R. C. Rollins 1482* (GH). CUSTER CO.: 1 mile above Rosita, 9000 ft., Sept. 4, 1943, *J. Ewan 15385* (DS). DOUGLAS CO.: 4.5 miles S. E. of Deckers, Aug. 17, 1941, *U. T. Waterfall 3476* (GH). EL PASO CO.: Black Forest near Colorado Springs, Aug. 22, 1939, *J. H. Ehlers 7876* (ARIZ, MICH). FREMONT CO.: 4 miles E. of Texas Creek, canyon of Arkansas River, Aug. 31, 1924, *R. Bacigalupi 1018* (DS, GH). JEFFERSON CO.: Buffalo Creek, Sept. 9, 1940, *H. L. Zobel s.n.* (TEX). LAKE CO.: Lake Creek, 9600 ft., Aug. 11, 1919, *I. W. Clokey 3482* (CAS, DS, F, GH). LARIMER CO.: Estes Park, 8000 ft., Aug. 14, 1904, *W. S. Cooper s.n.* (ARIZ). LAS ANIMAS CO.: Stonewall, Aug., 1917, *F. Beckwith 234* (DS).

MESA CO.: Uncompahgre Plateau, about 25 miles S. W. of Whitewater, 7500 ft., Aug. 12, 1937, *R. C. Rollins 1924* (DS). MINERAL CO.: Station A-2, Wagon Wheel Gap Experimental Station, 9600 ft., Aug. 6, 1911, *J. Murdoch, Jr. 4817* (F). MONTROSE CO.: Near 25 Mesa Ranger Station, T. 494, R. 13W., Uncompahgre National Forest, Aug. 30, 1947, *W. A. Weber 3541* (DS, TEX,UC). PARK CO.: Como, Leadville Forest, 2960 m., Sept. 14-15, 1915, *W. W. Eggleston 11983* (US). SAGUACHE CO.: 6 miles E. of Marshall Pass, Aug. 26, 1910, *I. Tidestrom 4084* (US). SAN MIGUEL CO.: Norwood Hill, 7000 ft., Aug. 10, 1912, *E. P. Walker 421* (DS, GH, US). TELLER CO.: North of Florissant, Aug. 27, 1939, *J. H. Ehlers 7915* (MICH). NEW MEXICO. BERNALILLO CO.: Sandia Mts., N. E. of Albuquerque, Aug. 23, 1926, *W. Koelz s.n.* (MICH). CATRON CO.: Mogollon Mts., near West Fork of Gila River, 7500 ft., Aug. 25, 1903, *O. B. Metcalfe 602* (ARIZ, US). COLFAX CO.: Vermejo Park, July & Aug., 1894, *Mrs. O. St. John 169* (GH, LL). DONA ANA CO.: Organ Mts., Aug., 1881, *G. R. Vasey s.n.* (F, US). GRANT CO.: Fort Bayard watershed, Aug. 20, 1905, *J. C. Blumer 221* (GH, US). HIDALGO CO.: Animas Valley, Oct. 2, 1893, *E. A. Mearns 2497* (US). LINCOLN CO.: White Mts., 7400 ft., Aug. 25, 1907, *E. O. Wooton & P. Standley 3678* (DS, MICH, US). RIO ARRIBA CO.: Near Dulce, Jicarillo Apache Indian Res., 2150-2470 m., Aug. 20, 1911, *P. C. Standley 8227* (US). SAN JUAN CO.: Tunitcha Mts., Navajo Indian Res., Aug. 8, 1911, *P. C. Standley 7612* (US). SAN MIGUEL CO.: Las Vegas, Dec. 10, 1927, *Arsene 19359* (CAS, GH). SANTA FE CO.: Santa Fe Canyon, 2500 m., July 31, 1926, *Arsene & Benedict 16906* (CAS, DS). SIERRA CO.: Kingston, 6800 ft., Sept. 14, 1904, *O. B. Metcalfe 1345* (CAS, F, GH, US). SOCORRO CO.: Magdalena Mts., Hop Canyon, Aug. 27, 1895, *C. L. Herrick 6262* (US). TAOS CO.: Taos Canyon, Sept. 8, 1929, *E. Whitehouse s.n.* (TEX). VALENCIA CO.: Mt. Taylor, 20 miles N. E. of Grants, 8250 ft., Aug. 30, 1933, *K. F. Parker 1911* (ARIZ). NEVADA. CLARK CO.: Fletcher Canyon, 2700 m., Aug. 26, 1939, *I. W. Clokey & A. Anderson 8572* (ARIZ, CAS, DS, F, GH, TEX, UC). LINCOLN CO.: Fay, 4 miles E. of Deer Lodge, Sept. 20, 1938, *P. Train 2543* (DS, UC). TEXAS. BREWSTER CO.: Chisos Mts., Aug. 15, 1931, *C. H. Mueller 8239* (CAS, GH, MICH, TEX, US). JEFF DAVIS CO.: Madeira Canyon, Scenic Loop Road, 21 miles from Ft. Davis, 6000 ft., Sept. 11, 1959, *W. L. Ellison & B. L. Turner 22* (TEX). UTAH. BEAVER CO.: Fillmore Nat'l. Forest, headwaters of Beaver Creek, Tushar Ranger Station, 2800 m., Aug. 8-9, 1914, *W. W. Eggleston 10444* (US). GARFIELD CO.: Sevier Forest, Panguitch Creek, Bunker Creek, 2700 m., Sept. 19, 1918, *W. W. Eggleston 14935* (GH). PIUTE CO.: Near Marysvale, Fate Mine, 9000 ft., Aug. 22, 1894, *M. E. Jones 5850* (F, US). SAN JUAN CO.: E. of Abajo Mts., Sept. 15, 1938, *A. Eastwood & J. T. Howell 6754* (CAS). WASATCH CO.: Wasatch Mts., Lake Blanche, Aug. 17, 1911, *Mrs. J. Clemens s.n.* (CAS). WASHINGTON CO.: Pine Valley, Aug. 20. 1918, *E. M. Hall 555* (US). WYOMING. ALBANY CO.: Laramie Peak, Aug. 7, 1895, *A. Nelson 1634* (GH, US).

MEXICO. BAJA CALIFORNIA: La Fresa, on trail from Vallecitos to

Valle Trinidad, Sierra San Pedro Martir, 6200 ft., Sept. 23, 1938, *I. L. Wiggins 9081* (DS, GH, US). 5 miles N. of La Encantada on road to Vallecitos, Sierra San Pedro Martir, Sept. 22, 1938, *I. L. Wiggins 9070* (DS, US). Sierra San Pedro Martir, Meling's Ranch, Sept. 18, 1930, *I. L. Wiggins & D. Demaree 4886* (DS, MICH, US). Vallecitos, Sierra San Pedro Martir, 8060 ft., Sept. 21, 1930, *I. L. Wiggins & D. Demaree 4967* (DS, F, GH, MICH, UC, US). CHIHUAHUA: Between Col. Garcia and Pratt's Ranch below Pacheco, Aug. 22-24, 1899, *E. W. Nelson 6263* (GH, US). Near Col. Garcia, 7500 ft., Aug. 19, 1899, *C. H. T. Townsend & C. M. Barber 268* (GH, US). Sierra Madre, Aug. 3, 1899, *C. H. T. Townsend & C. M. Barber s.n.* (US). COAHUILA: Del Carmen Mts., Sept. 13, 1936, *E. G. Marsh, Jr. 904* (GH). SONORA: San José Mts., Oct. 6, 1892, *E. A. Mearns 1046* (US). Rancho de Cruz Diaz, Aug. 7, 1940, *E. A. Phillips 429* (GH, MICH). Sierra de El Tigre, Las Tierritas de El Temblor, Aug. 18-24, 1940, *S. S. White 3349* (ARIZ, GH, MICH). Sierra de El Tigre, Las Tierritas de El Temblor, Aug. 18-24, 1940, *S. S. White 3416* (GH, MICH). El Rancho del Roble, N. E. of El Tigre, 6000 ft., Sept. 2-13, 1941, *S. S. White 4191* (GH, MICH). El Rancho del Roble, N. E. of El Tigre, 6000 ft., Sept. 2-13, 1941, *S. S. White 4300* (ARIZ, GH, LL, MICH).

3. *Bahia autumnalis* sp. nov.[8]

Plantae annuae biennesve 30-120(-150) cm. alt. Caules e radice terete ligneo singuli erectique orientes (interdum 2 vel 3 caules principales e corona radicis divergentes), ad basim saepe amplificati, super amplificationem 3-10 mm. diam., laxe in paniculis ramosi, omnibus ramis terminalibus in 2 ad multos pedunculos monocephalicos abeuntibus; caulis costatus pubescens farinosus, paucos ad multos globulos exsudati superficiei agnatos (glandibus stipitatis elongatis raro praeditus) habens; pedunculi 5-40 mm. long., pubescentes aut tomentosi, farinosi, globulos exsudati velut in caulibus habentes, pilis glandularibus rarissimis. Folia 4-11 cm. long. plus minusve pubescentes, raro farinosa, paucos ad multos globulos exsudati in depressionibus laminae puncticulatae habentia, ad basim extremam opposita aut quasi opposita, alibi alterna, ternate divisa, omnibus segmentis in multa segmenta linearia ovata 3-6 mm. lat. iterum divisis, folia summa in segmenta linearia integra ternate divisa. Capitulum maturum 5-10 mm. alt., 10-15 mm. diam. Involucrum late campanulatum, bracteae involucri 18-24 in 2-3 ordinibus, maturae reflexae virides, marginibus membranaceis, pubescentes, globulis exsudati saepe farinosae, 4-6 mm. long., 1-2.5 mm. lat., obovatae aut lanceolatae, apice acuminato, costa aegre evoluta aut nulla. Receptaculum alinquantulum convexum, alveolatum, 2-3 mm. diam. Flosculi radii 15-20, flavi pistillati fertiles; ligulae 4-4.5 mm. long., 1.5-3 mm. lat., oblongae, apice 3-lobato aut undulato; tubus 0.3 mm. diam., 1.3-1.6 mm. long., aliquot glandibus brevibus stipitatis c.

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[8]Grateful acknowledgment is made to Dr. Hannah T. Croasdale of Dartmouth College who prepared the Latin description.

0.1 mm. long. praeditus. Flosculi disci 90-140, perfecti fertilesque, flavi, regulares aut in peripheria satis zygomorphici, 2-3.5 mm. long.; tubus et iugulum inferius glandibus paucis ad multas brevibus stipitatis praedita; tubus 0.3 mm. diam., 0.7-1 mm. long.; iugulum campanulatum, 1-1.5 mm. long.; lobi 5, in flosculis maturis reflexi, 0.7-1.3 mm. long., ratione iuguli et lobi maxime variante, antherae 1.5-1.8 mm. long., maturae partim exsertae; rami styli complanati, 0.8-1.3 mm. long., lineas stigmaticas manifestas in marginibus superioribus habentes, maturi reflexi, apicibus obtusis amplificatione papillosa; achaenia 2.5-4 mm. long., anguste obpyramidalia quadrilateralia, brunnea ad atra, interdum striata, in angulis prope basim valde hispida, supra sparse pubescentia, lateribus glabris; pappus ex 11-12 squamis scariosis oblanceolatis, marginibus laceratis, 1-13 mm. long., 0.3-0.6 mm. lat., ad basim incrassatis, costas plus minusve evolutas habentibus, costis fere ad apices extensis, constans.

Plants annual or biennial, 30-120(-150) cm. tall. Stem single and erect from a woody taproot (occasionally 2 or 3 major stems forming from the root-crown following injury), frequently enlarged at the base, 3-10 mm. in diameter above this enlargement, loosely and paniculately branched, each terminal branch culminating in 2-numerous monocephalic peduncles, ribbed, variously pubescent and farinose with few to numerous globules of exudate adnate to the surface (rarely with elongated stipitate glands); peduncles 0.5-4 cm. long, pubescent or tomentose, farinose, globules of exudate as on the stem, almost never with stipitate glands. Leaves opposite or nearly so at the extreme base, otherwise alternate, ternately divided, each segment again divided into numerous linear-ovate segments 3-6 mm. wide, uppermost leaves ternately divided into linear, entire segments, 4-11 cm. long, more or less pubescent, rarely farinose with few to numerous globules of exudate in the depressions of the puncticulate divisions. Mature heads (including florets) 5-10 mm. high, 10-15 mm. in diameter. Involucre broadly campanulate; involucral bracts variously pubescent, often farinose with globules of exudate, 18-24 in 2-3 series, reflexing with age, membranous margins, 4-6 mm. long, 1-2.5 mm. wide, obovate or lanceolate, apex acuminate, midrib weakly developed or absent. Receptacle somewhat convex, alveolate, 2-3 mm. in diameter. Ray florets 15-20, yellow, pistillate, fertile; ligule 4-4.5 mm. long, 1.5-3 mm. wide, oblong with a 3-lobed or undulate apex; tube 0.3 mm. in diameter, 1.3-1.6 mm. long, glandular-stipitate. Disc florets 90-140, perfect and fertile, yellow, regular or somewhat zygomorphic peripherally, 3-3.4 mm. long; tube and lower throat with few to numerous short stipitate glands; tube 0.3 mm. in diameter, 0.7-1 mm. long; throat campanulate, 1-1.5 mm. long; lobes 5, reflexed at maturity, 0.7-1.3 mm. long, throat-lobe ratio highly variable; anthers 1.5-1.8 mm. long, partially exserted at maturity; style branches flattened, 0.8-1.3 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices

obtuse with papillose enlargements; achenes 2.5-4 mm. long, narrowly obpyramidal, 4-sided, brown to black, occasionally striate, markedly hispid on the angles near the base and scatteredly pubescent above, the faces glabrous; pappus of 11-12 scarious oblanceolate scales with lacerate margins, 1-1.3 mm. long, 0.3-0.6 mm. wide, thickened at the base and with more or less well-developed midribs, the latter extending almost to the apices. Chromosome number, $n = 12$. Holotype (TEX). "31 mi. S. of Galeana," October 1, 1960, Nuevo León, Mexico, *M. C. Johnston & J. Crutchfield 5856.* (Isotypes to be distributed.)

DISTRIBUTION: Calcareous alluvial, sandy clay and shaly soils of Nuevo León and western Coahuila, Mexico, mostly along roadsides in arid or semi-arid habitats from 1500-3000 (-5000) ft. (Fig. 42). Principal flowering dates August-November.

Representative specimens of this new species have in the past been identified as *B. biternata.* It is superficially similar to *B. biternata* and *B. pedata* but clearly distinct. As indicated in the key to species, there are several morphological features as well as edaphic and geographic considerations which differentiate between the taxa. In addition, *B. biternata* and *B. pedata* occur mostly in grasslands at elevations from 3000-6000 ft., while *B. autumnalis* is found from 1500-3000 (-5000) ft., in desert or semi-arid habitats.

SPECIMENS EXAMINED: MEXICO. COAHUILA: 10 miles N. of Saltillo toward Piedras Negras, Oct. 14, 1959, *M. C. Johnston & J. Graham 4319* (TEX). NUEVO LEÓN: 13 miles out of Linares toward Iturbide, Sept. 30, 1960, *M. C. Johnston & J. Crutchfield 5836* (TEX). 1 mile W. of Iturbide, Sept. 30, 1960, *M. C. Johnston & J. Crutchfield 5843* (TEX). 5 miles below San Juan de Iturbide toward Linares, Oct. 9, 1949, *M. C. Johnston & J. Graham 4241* (TEX). Mamulique Pass, 23 miles S. of Sabinas Hidalgo, Nov. 8, 1960, *M. C. Johnston & J. Crutchfield 6045* (TEX). 13 miles W. of Linares toward Galeana, 1900 ft., Oct. 9, 1959, *M. C. Johnston & J. Graham 4246* (TEX). 15.5 miles S. of Sabinas Hidalgo toward Monterrey, 2000 ft., Nov. 10, 1959, *M. C. Johnston & J. Graham 4616* (TEX). Galeana, Arroyo Hondo, Aug. 1, 1935, *C. H. Mueller 2329* (ARIZ, F, GH, MICH, TEX). Horsetail Falls, 30 miles S. E. of Monterrey on Hwy. 85, Nov. 30, 1948, *W. M. Thompson 282* (TEX).

4. *Bahia biternata* Gray

Bahia biternata Gray, Pl. Wright. 2:95. 1853. Holotype examined (GH): "Gravelly hills near Ojo de Gavilan," August, 1851, New Mexico, *C. Wright 1256.* One probable isotype was also examined (UC). *Schkuhria biternata* (Gray) Gray, Proc. Am. Acad. 9:199. 1874. *Erio-*

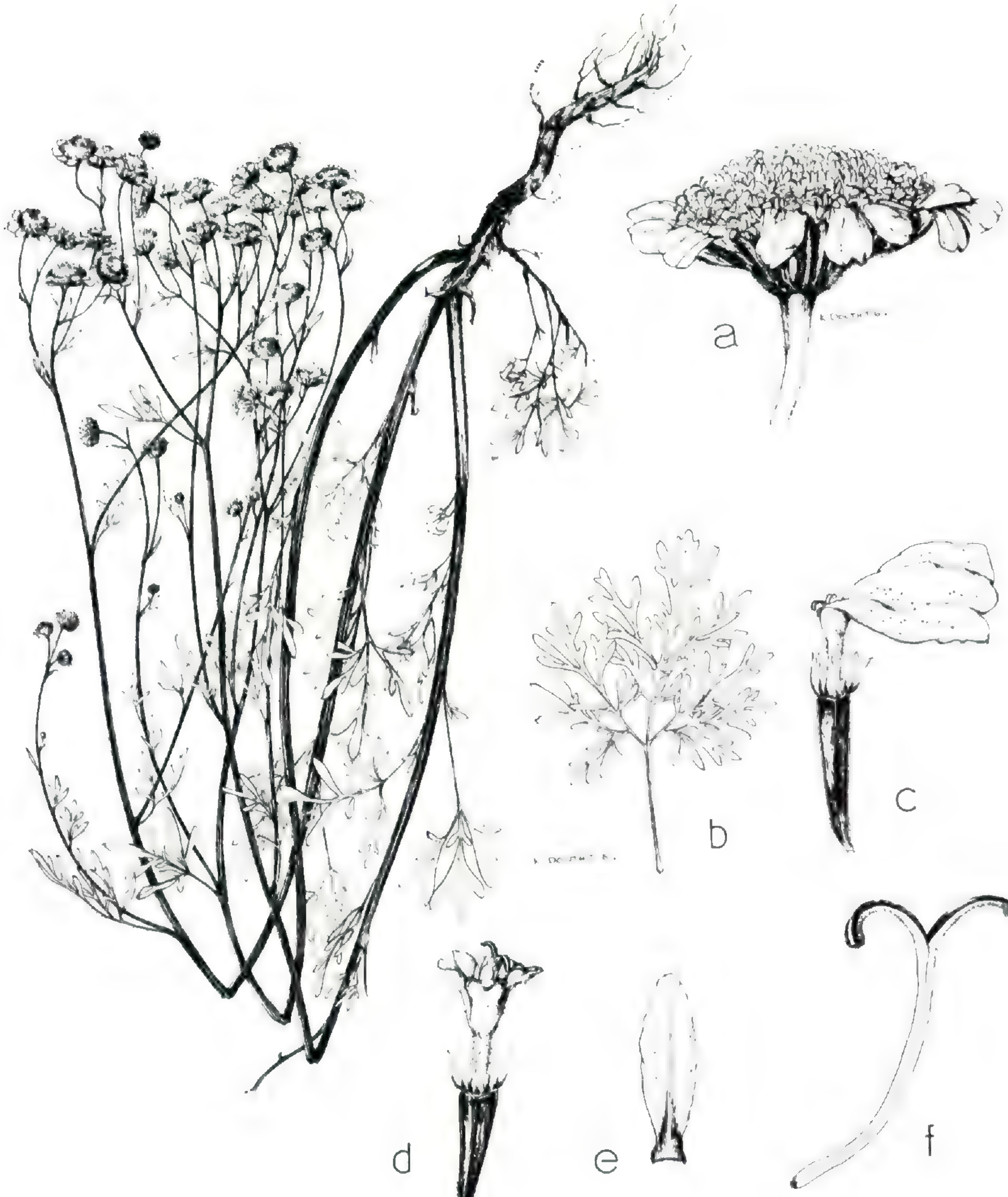

Fig. 47. *B. autumnalis* (Holotype, *Johnston 5856*, TEX). Entire plant, × 2/7. a. Head, × ca. 2. b. Mid-stem leaf, × ca. 2/7. c. Ray floret, × ca. 3. d. Disc floret, × ca. 3. e. Pappus scale, × ca. 15. f. Style branches, × ca. 9.

phyllum biternatum (Gray) Kuntze, Rev. Gen. Pl. 1:337. 1891. *Villanova biternata* (Gray) Woot. & Standl., Contrib. U. S. Nat. Herb. 19: 725. 1915.

Plants annual, 30-60(-100) cm. tall. Stem single and erect from a taproot (occasionally 2 or more major stems forming from the root-crown following injury), 1-4 mm. in diameter, loosely and paniculately branched, each terminal branch culminating in 1-4 monocephalic peduncles, lower stem pubescent and ribbed (rarely with stipitate glands), upper stem both pubescent and stipitate-glandular; peduncles 1-9 cm. long, variously short pubescent, farinose with few or no stipitate glands. Leaves opposite or nearly so at the extreme base, otherwise alternate, biternately divided into linear or ovate-lanceolate segments 1-3(-4) mm. wide, uppermost leaves ternately divided into 3 simple and entire segments, 2-4 cm. long (2-3 times as large in occasional robust plants), pubescent, farinose. Mature heads (including florets) 5-8 mm. high, 8-15(-20) mm. in diameter. Involucre broadly campanulate; involucral bracts pubescent and farinose, rarely with globules of exudate, 14-16 in 2 series with 1 or more outer bractlets, reflexing with age, membranous margins rarely tinged with purple, 2.7-5 mm. long, 1-2.5 mm. wide, obovate or oblong, apex obtuse, midrib weakly developed. Receptacle flat or slightly convex, alveolate, 1-1.5 mm. in diameter. Ray florets 8-14, yellow, pistillate, fertile; ligule 2.5-3.2(-10) mm. long, 1.6-2(-3) mm. wide, broadly spatulate or ovate with irregularly undulate or 3-lobed apex; tube 0.3 mm. in diameter, 1-1.3 mm. long with numerous stipitate glands. Disc florets 45-80, perfect and fertile, yellow, regular, 2.8-3.5 mm. long; tube and throat with numerous stipitate glands; tube 0.3 mm. in diameter, 1-1.3 mm. long; throat campanulate, 1.2-2 mm. long; lobes 5, reflexed at maturity, 0.5-0.7 mm. long; anthers 1.5-1.8 mm. long, partially exserted at maturity; style branches flattened, 0.6-0.8 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices obtuse or truncate with a papillose enlargement; achenes 1.8-3.2 mm. long, narrowly obpyramidal, 4-sided, brown to black, hispid, the hairs about 0.2 mm. long (occasionally longer at the attenuate base); pappus of 10-14 scarious, obovate or oblanceolate scales; scales muticous, 0.5-1.4 mm. long, 0.4-0.6 mm. wide on the ray and exterior disc florets but lanceolate with an excurrent scabrous midrib, 1.2-2.3 mm. long and 0.2-0.5 mm. wide on the inner disc florets. Chromosome number not determined.

DISTRIBUTION: Granitic outcrops and open rocky slopes of south-central Arizona and S. W. New Mexico, mostly in grasslands and scrub oak habitats from 4000-5000 ft. (Fig. 44). Principal flowering dates May and September-October.

This species has apparently been little collected considering the small number of specimens which were available for

study. *B. bitemata* is closely related to *B. pedata* and *B. glandulosa*, and the three taxa have been variously confused by several workers. For a consideration of these relationships, see the discussions under the latter two species.

SPECIMENS EXAMINED: Whipple's Exploration for a Railway Rt. from Miss. R. to Pacific Ocean, near 35th parallel, Mule Springs, Aug., 1854, *J. M. Bigelow s.n.* (GH). ARIZONA. GILA CO.: Apache Trail and adjacent region, Horsedam Mesa, May 21, 1929, *A. Eastwood 17373* (CAS). Sierra Ancha Mts., lower Parker Creek Canyon, 4500 ft., Sept. 3, 1946, *F. W. Gould & R. K. Hudson 3834* (ARIZ). PINAL or GILA CO.: Summit of Superior-Miami Hwy., Oct. 10, 1926, *R. H. Peebles, G. J. Harrison & T. H. Kearney 3228* (ARIZ, US). PINAL CO.: Sacaton, May 8, 1926, *G. J. Harrison 1912* (ARIZ). NEW MEXICO. Ojo de Gavilan, Aug., 1851, *G. Thurber 1062* (GH). DONA ANA CO.: Valley of the Rio Grande, below Donana, w/o date, *C. C. Parry, J. M. Bigelow, C. Wright, & A. Schott 622* (US). GRANT CO.: 17 miles W. N. W. of Silver City, Sept. 25, 1944, *F. A. Barkley 14777* (TEX, UC).

5. *Bahia pedata* Gray

Bahia pedata Gray, Pl. Wright. 1:123. 1852. Holotype examined (GH): "Between western Texas and El Paso, N. Mex.," May-Oct., 1849, *C. Wright 327*. Probable isotype examined (GH). *Schkuhria pedata* (Gray) Gray, Proc. Am. Acad. 9:199. 1874. *Eriophyllum pedatum* (Gray) Kuntze, Rev. Gen. Pl. 337. 1891.

Plants annual (biennial?), 30-100(-120) cm. tall. Stem single and erect from a taproot (rarely 2 or more stems forming from the root-crown following injury), 2-6 mm. in diameter, paniculately branched, each terminal branch culminating in 1-4 monocephalic peduncles, ribbed, variously pubescent and glandular with numerous globules of exudate adnate to the surface and/or with numerous stipitate glands; peduncles 1-8 cm. long and stipitate-glandular. Leaves commonly in a close spiral arrangement on the lower stem, alternate, pedately divided into three segments, each lateral segment 2-parted (occasionally multifid), the middle segment of 3-7 lobes, ultimate lobes obovate or broadly oblong 2-5 mm. wide, uppermost leaves simple and entire or ternately divided into entire linear segments, 4-11 cm. long, pubescent, frequently farinose with numerous globules of exudate in the depressions of the puncticulate blade. Mature heads (including florets) 5-8 mm. high, 15-20 mm. in diameter. Involucre broadly campanulate; involucral bracts short stipitate-glandular, 13-17 in 2 series with 1 or more outer bractlets, reflexing with age, membranous margins rarely tinged with red or purple, scattered pubescence, 4-6 mm. long, 1.5-2.5 mm. wide, oblong-oblanceolate, apex obtuse, midrib weakly developed or absent. Receptacle somewhat convex, alveolate, 2.5-3 mm. in diameter. Ray florets 10-15, yellow, pistillate, fertile; ligule 5-6(-7) mm. long, 2.5-4 (-5) mm. wide, oblong with truncate irregular apex; tube 0.3-0.4 mm.

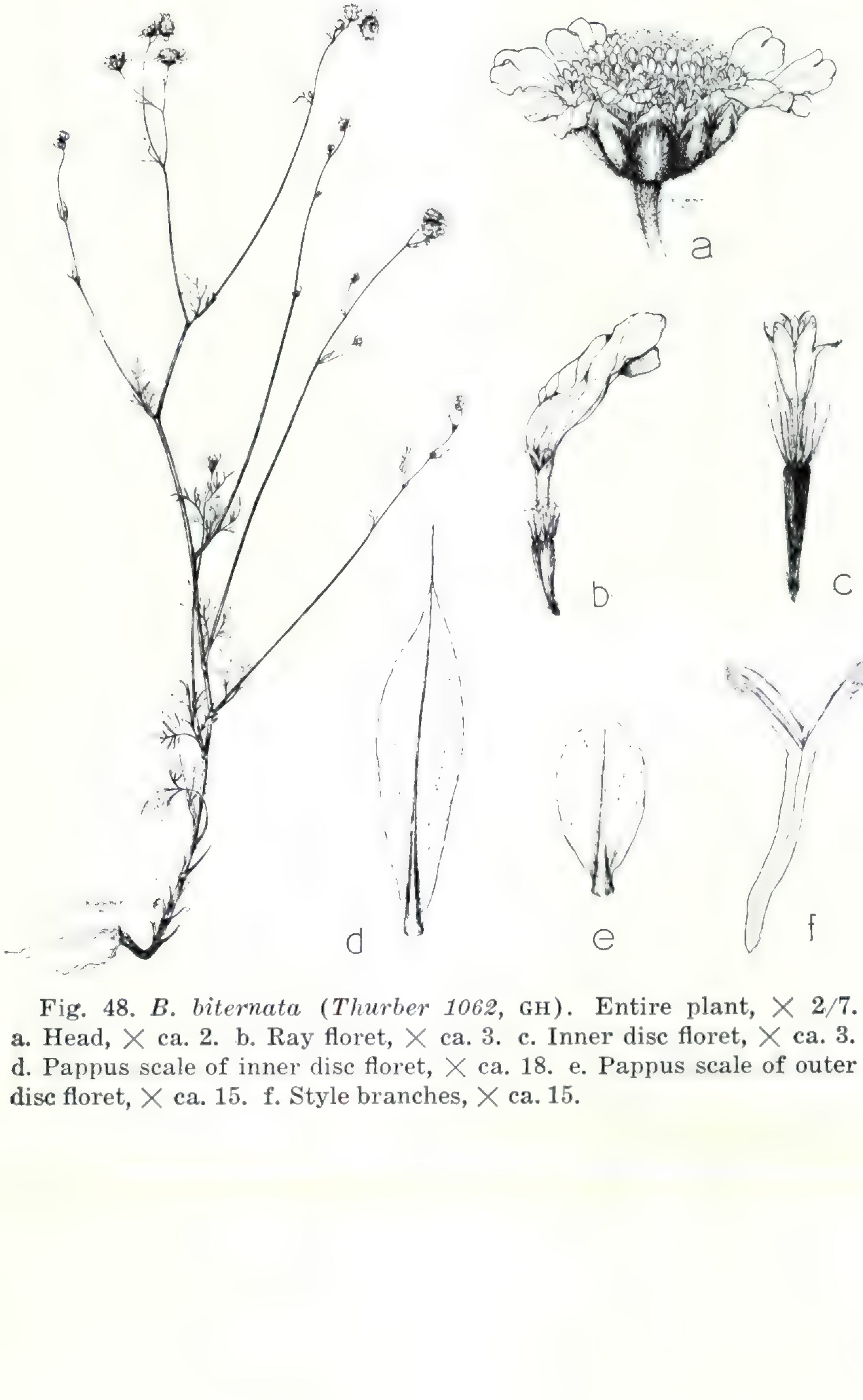

Fig. 48. *B. biternata* (*Thurber 1062*, GH). Entire plant, × 2/7. a. Head, × ca. 2. b. Ray floret, × ca. 3. c. Inner disc floret, × ca. 3. d. Pappus scale of inner disc floret, × ca. 18. e. Pappus scale of outer disc floret, × ca. 15. f. Style branches, × ca. 15.

in diameter, 1.5-2 mm. long with numerous stipitate glands. Disc florets 70-110, perfect and fertile, yellow, regular, 3-4.5 mm. long; tube and lower throat with numerous stipitate glands; tube 0.3-0.4 mm. in diameter, 1-1.8 mm. long; throat campanulate, 0.5-1(1.5) mm. long; lobes 5, reflexed at maturity, 0.8-1.3 mm. long; anthers 1.5-2 mm. long, partially exserted at maturity; style branches flattened, 0.7-1 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices obtuse with papillose enlargement; achenes 2.4-4(-4.5) mm. long, narrowly obpyramidal, 4-sided, brown to black, often striate, hispid on the angles near the base, the hairs to 0.5 mm. long, merely hispidulous on the upper angles and sides; pappus of 10-15 scarious oblanceolate or spatulate scales; scales 1-1.5 mm. long, 0.3-0.5 mm. wide, thickened at the base with the midrib usually extending ½-¾ the length (occasionally minutely excurrent). Chromosome number, $n = 12$.

DISTRIBUTION: Rocky calcareous, sandy or igneous soils of grasslands in western Texas, southern New Mexico, and northern Coahuila and Chihuahua, 3000-6000 ft., (Fig. 42). Principal flowering dates June-November.

B. pedata is allopatric in a small portion of its range with *B. biternata*. In the past there has been much confusion in the recognition of specimens due to the inadequate circumscription of the taxa. Using the types as a point of reference, I found the distinguishing character of inner achenal pappus scales with excurrent midribs in *B. biternata* to be consistently correlated with other characters which mark the taxon (see the key to species). However, additional study of this particular problem should be conducted when a greater number of specimens of *B. biternata* is available. Populational analyses in western New Mexico and eastern Arizona should prove particularly important in this connection.

REPRESENTATIVE COLLECTIONS: NEW MEXICO. DONA ANA CO.: Mesa W. of Organ Mts., Aug. 29, 1902, *E. O. Wooton s.n.* (ARIZ, US). EDDY CO.: 5 miles N. of Carlsbad, Sept. 15, 1956, *J. W. MacSwain s.n.* (UC). GUADALUPE CO.: 2.7 miles E. of Newkirk, Aug. 17, 1953, *U. T. Waterfall 11755* (TEX, UC). QUAY CO.: Tucumcari, Aug. 30, 1910, *G. L. Fisher 8* (US). SIERRA CO.: 2 miles E. of Lava, Casa Grande, July 7, 1933, *S. B. Benson 343* (UC). TEXAS. BREWSTER CO.: Chisos Mts., Aug. 1, 1931, *C. H. Mueller 8228* (GH, TEX, US). CULBERSON CO.: Van Horn, Sept. 5, 1925, *B. C. Tharp 3885* (TEX, US). EL PASO CO.: El Paso, Sept. 29, 1884, *M. E. Jones 4340* (ARIZ, F, GH, US). HUDSPETH CO.: 8 miles E. of Sierra Blanca, 4600 ft., Aug. 13, 1940, *F. Shreve 9555* (ARIZ, MICH, UC). JEFF DAVIS CO.: Musquiz Canyon, May 9, 1941, *B. H.*

Fig. 49. *B. pedata* (*Ellison 16*, TEX). Entire plant, × 2/7. a. Head, × ca. 2. b. Ray floret, × ca. 5. c. Disc floret, × ca. 6. d. Pappus scale, × ca. 12. e. Style branches, × ca. 11.

Warnock 751 (ARIZ, GH, TEX). PRESIDIO CO.: Marfa, San Esteban Lake, July, 1936, *L. C. Hinckley s.n.* (F, GH, TEX). REEVES CO.: 20 miles E. of Balmorhea on Hwy. 290, Sept. 11, 1959, *W. L. Ellison & B. L. Turner 16* (TEX).

MEXICO. CHIHUAHUA: 78 miles N. of Parral on Hwy. 45, 5100 ft., Sept. 4, 1960, *W. L. Ellison & A. Garcia 139* (TEX). Road from Laguna Palomas to Jimenez via Escalon, Sept. 22, 1938, *I. M. Johnston 7835* (GH). 2 miles S. of San Fernando, 40 miles N. E. of Camargo, Sept. 25, 1938, *I. M. Johnston 7942* (GH). Northeastern part of state, 10 miles E. of Chapo on road from Ojinaga S. E. to San Carlos between Alamos Chapo and Alamitos, Aug. 8, 1940, *I. M. Johnston & C. H. Mueller 17* (GH). Meoqui, Aug. 6, 1936, *H. LeSueur 1235* (F). Plains, Aug. 17, 1885, *C. G. Pringle s.n.* (F). Near Chihuahua, Oct. 24, 1885, *C. G. Pringle 308* (DS, F, GH, MICH, US). 16 miles N. of Escalon, 4400 ft., Sept. 22, 1938, *F. Shreve 8860* (ARIZ, US). Oct., 1911, *E. Stearns 52* (F). 10 km. S. of Rancho de Encinillas, July 6, 1941 *R. M. Stewart 704* (GH). 8 miles N. of San Lucas on road to Chihuahua, Aug. 8, 1939, *S. S. White 2328* (MICH). COAHUILA: Western part of state, Sierra de San Antonio, Sept. 2-3, 1940, *I. M. Johnston & C. H. Mueller 935* (GH). Western part of state between San Rafael and San Vicente, Sept. 8, 1940, *I. M. Johnston & C. H. Mueller 1056* (GH). Del Carmen Mts., Sept. 13, 1936, *E. G. Marsh, Jr. 904* (F, TEX). 24 km. N. of Castillon, close to Chihuahuan boundary, June 15, 1941, *R. M. Stewart 540* (GH). Villa Acuña, near Santo Domingo, July 4, 1936, *F. L. Wynd & C. H. Mueller 465* (ARIZ, GH, US).

6. *Bahia ambrosioides* Lagasca

Bahia ambrosioides Lag., Gen. et. Sp. Nov. 30. 1816. Holotype: Chile, "habitat circa Concepción urbem in Chilensi Regno. (v.s.)." The type, if preserved, should be located in the Instituto Botánico Antonio Jose Cavanilles, Madrid, Spain, but according to Dr. Elena Paunero (personal communication), curator of the herbarium, no such specimen could be found in their collections. *Stylesia ambrosioides* (Lag.) Nutt., Trans. Am. Phil. Soc. Ser. II 7:377. 1841. (Nuttall knowingly proposed the new generic name *Stylesia* for the South American elements of *Bahia* and, contrary to the present Code, restricted the name *Bahia* to the North American species.) *Eriophyllum ambrosioides* (Lag.) Kuntze, Rev. Gen. Pl. 1:336. 1891.

Achyropappus maritimus Poepp. ex DC., Prod. 5:657. 1825. (In synonymy).

Stylesia puberula Nutt., Trans. Am. Phil. Soc. Ser. II 7:377. 1841.

Plants perennial, suffruticose, 30-100 cm. tall. Basal stems furrowed, somewhat farinose, upper stems glandular-pubescent and/or viscid with few to numerous leaves and leafy shoots, the branches striate, glandular, or occasionally pilose; peduncles 1-3(-5) cm. long, glandular. Leaves opposite, ternately bipinnatifid to multifid with narrow linear or ovate-oblanceolate segments 0.5-5 mm. wide, petioles partially clasp-

ing the stem, 1-3 cm. long, nearly glabrous to pilose, occasionally somewhat farinose, impressed punctate with globules of exudate in the depressions. Mature heads (including florets) 5-8 mm. high, 15-20 mm. in diameter. Involucre turbinate-campanulate; involucral bracts pubescent and glandular with an exudate often appearing as a pulverulence, 5-8 in 1-2 series (with 1 or 2 occasional small outer bractlets), reflexing with age, 6-8 mm. long, 2-4.5 mm. wide, broadly ovate, the margins membranous, apex obtuse or somewhat acute, midrib either weakly discernible or absent. Receptacle somewhat convex, alveolate (occasionally somewhat fimbrillate), 1-2.5 mm. in diameter. Ray florets 4-9, white or cream-colored, pistillate, fertile; ligules 5-8 mm. long, 2-5 mm. wide, obovate with notched, undulate or irregularly-lobed apices; tube about 0.5 mm. in diameter, 2-3 mm. long, glandular-pubescent, the hairs to 0.4 mm. long. Disc florets 30-70, perfect and fertile, yellow, regular, 2-4(-5) mm. long; tube stipitate-glandular, 1-1.8(-2.3) mm. long, about 0.5 mm. in diameter; throat campanulate to funnelform, 0.5-1.5 mm. long; lobes 5, reflexed at maturity, equal, 0.5-1.5 mm. long; anthers 1.3-2 mm. long, partially exserted at maturity; style branches flattened, 1-2 mm. long with well-defined stigmatic lines along the upper margin, reflexed at maturity, apices obtuse with papillose enlargements; achenes 2-4.5 mm. long, narrowly obpyramidal, 4-sided, brown sparingly pubescent; pappus of 7-10 scarious ovate or obovate colorless purple-tinged scales; scales 0.7-2.3 mm. long, 0.3-1 mm. wide, thickened at the base but almost never with a distinct midrib. Chromosome number not determined.

DISTRIBUTION: Rocky arid slopes, open crests and canyons and sandy dunes from sea level to 3600 feet, mostly along the coast of Chile from about latitude 20° to 37° S. (Fig. 50). Principal flowering dates July-February.

Nuttall, when proposing the illegitimate genus *Stylesia*, indicated the existence of two South American species, *S. ambrosioides* and *S. puberula*. He distinguished the former as having leaves trifid or twice trifid and puberulous as opposed to leaves ternately bipinnatified and minutely pubescent, and achenes twice the length of the pappus as opposed to achenes just half as long but equal in length to the pappus. I could make no adequate separation of the specimens on the basis of leaf character, and a careful analysis of achene length and relative achene-pappus length disclosed no basis for the recognition of two taxa. Two floral characters which are worthy of note, but which showed no meaningful systematic pattern, were the markedly different disc tube lengths and the ratio of the pappus length to corolla length

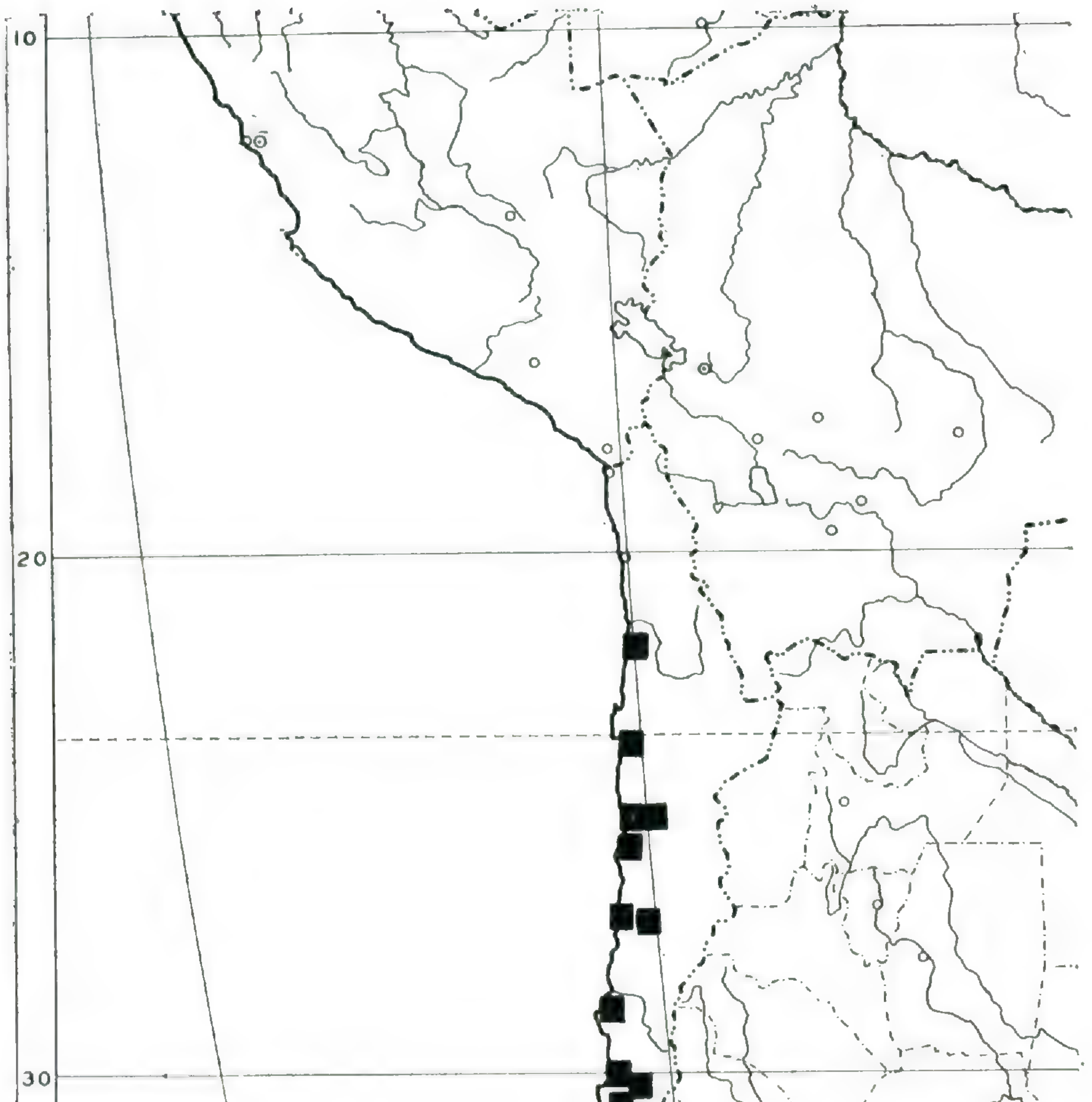

Fig. 50. Map of portion of west coast of South America showing distribution of *B. ambrosioides*.

Fig. 51. *B. ambrosioides* (*Werdermann 811*, GH). Entire branch, × 2/7. a. Head, × ca. 2. b. Ray floret, × ca. 3. c. Disc floret, × ca. 3. d. Pappus scale, × ca. 12. e. Style branches, × ca. 9.

of the disc florets, this varying from 0.2-0.9. A single specimen was noted which had lanceolate pappus scales with distinct midribs *(Looser 4265)*.

One sheet examined *(I. M. Johnston 4913)* was of particular interest. On the label, Johnston indicated this to be a new variety (unpublished) with the following notation. "This collection is peculiar because of its very extreme glandularity and because it comes from so very far inland away from the coast." The total character of the several branches on the sheet is within the range of variation which I found for the species except for the degree of glandulosity and the presence of an exceptionally long tube on the disc florets of one plant (1.7-2.3 mm. long). On the same sheet, however, was a specimen with tubular dimensions within the normal limits.

REPRESENTATIVE COLLECTIONS: CHILE. ACONCAGUA: Las Salinas near Viña del Mar, July 29, 1928, *G. Looser 713* (GH). ANTOFAGASTA: DEPTO. TALTAL, vicinity of Aguada de Miguel Diaz, about 24°35′ S., Dec. 1-4, 1925, *I. M. Johnston 5326* (GH, US). DEPTO. TOCOPILLA, Tocopilla, 6 km. N., Oct. 18, 1925, *I. M. Johnston 3587* (GH). DEPTO. TALTAL, vicinity of Paposo on hill directly back of Punta Grande, Nov. 29, 1925, *I. M. Johnston 5226* (GH, US). Antofagasta, 100-300 m., April 3, 1925, *F. W. Pennell 13023* (F, GH). DEPTO. TALTAL, Taltal, 500 m., Oct., 1925, *E. Werdermann 811* (CAS, F, GH, UC, US). ATACAMA: DEPTO. COPIAPO, vicinity of Caldera, Oct., 1894, *E. E. Gigoux 24* (GH). DEPTO. CHANARAL, vicinity of Puerto de Chanaral in hills back of El Barquito, Oct. 28-29, 1925, *I. M. Johnston 4791* (GH, US). DEPTO. COPIAPO, Quebrada San Miguel above Los Marayes, 1200 m., Nov. 7, 1925, *I. M. Johnston 4913* (GH). Desert of Atacama, Sept.-Oct., 1890, *T. Morong 1130* (F, GH, MICH, US). COQUIMBO: DEPTO. OVALLE, Fray Jorge, 30°40′ S. lat., Sept. 26, 1935, *C. Munoz B111* (GH). DEPTO. LA SERENA, Sept. 15, 1935, *C. Munoz B-27* (ex part.) (GH). Valley of Rio Turbio near Dieguitas, 700 m., Nov. 20, 1935, *J. West 3914* (GH, UC). Coquimbo, July-Aug., 1856, *W. H. Harvey s.n.* (US). Coquimbo, Feb., 1903, *G. T. Hastings 591* (UC, US). DEPTO. ELQUI, Hacienda Pangue, 20-25 km. S. of Vicuña on road to Hurtado, 1200 m., Oct. 13, 1940, *G. Looser 4265* (GH). Masefuera, rocky coast near Casas, March 13, 1917, *C. & I. Skottsberg 443* (US). SANTIAGO: Llolleo, dunes, Aug., 1921, *G. Montero 34* (GH). Santiago, Dec., 1922, *Claude-Joseph 2225* (US). Serena, Oct., 1927 *Claude-Joseph 5095* (US). VALPARAISO: Quintero, 90 m., Sept., 1923, *E. Werdermann 36* (CAS, F, GH, UC, US). Valparaiso, 1888 (US). Valparaiso, 1829, *Bertero 839* (GH). Valparaiso, Oct., 1925, *Claude-Joseph 3645* (US). Valparaiso, *Gay 197* (GH). Valparaiso, Feb.,

1846, *Gaudichaud 160* (DS). Near Valparaiso, Sept. 22, 1914, *Mr. & Mrs. J. N. Rose 19152* (US). Valparaiso, *Wilkes s.n.* (US).

7. *Bahia bigelovii* Gray

Bahia bigelovii Gray, Torr. Bot. Mex. Bound. 96. 1859. Holotype examined (GH): "Valley of the Limpio," W. Texas, July, 1852, *Bigelow s.n. Schkuhria bigelovii* (Gray) Gray, Proc. Am. Acad. 9:199. 1874. *Eriophyllum bigelovii* (Gray) Kuntze, Rev. Gen. Pl. 1:337. 1891.

Plants annual, 15-35 cm. tall. Stem erect from a slender taproot, 1-2 mm. in diameter, branched, each terminal branch culminating in 1-4 monocephalic peduncles, internodes 4-8(2.5) cm. long, ribbed sparingly pubescent with infrequent globules of exudate adnate to the surface; peduncles 3-10 cm. long, sparingly pubescent at the base but becoming tomentose and with stipitate glands and globules of exudate near the top. Leaves opposite becoming alternate on the upper stems, 3-parted into linear entire or secondarily divided, the segments 1(-2) mm. wide, 1.5-5 cm. long, sparingly pubescent, impressed punctate or puncticulate with globules of exudate in the depressions. Mature heads (including florets) 4-7 mm. high, 8-16 mm. in diameter. Involucre broadly campanulate; involucral bracts more or less pubescent (rarely with stipitate glands) and with numerous globules of exudate, 10-14 (-18) in 2 series, reflexing with age, the margins membranous, rarely tinged with purple, 3.5-4.5 mm. long, 1-1.6 mm. wide, obovate, the apex acute, acuminate or obtuse and the midrib weakly discernible or absent. Receptacle flat, alveolate, 0.7-1.2 mm. in diameter. Ray florets 5-9, yellow, pistillate, fertile; ligule 3.5-4.5 mm. long, 1.5-3 mm. wide, elliptical with a truncate irregularly undulate apex; tube 0.2-0.3 mm. in diameter and 0.6-1 mm. long with few to numerous stipitate glands. Disc florets 50-85, perfect and fertile, yellow, regular or somewhat zygomorphic peripherally, 2.5-3 mm. long; tube stipitate-glandular, 0.2-0.3 mm. in diameter, 0.8-1.2 mm. long; throat broadly campanulate, 0.8-1.2 mm. long; lobes 5, reflexed at maturity, 0.5-0.8 mm. long; anthers 1-1.3 mm. long, partially exserted at maturity; style branches flattened, 0.5-0.7 mm. long, reflexed at maturity, apices obtuse with papillose enlargements; achenes 2-2.5(-4.3) mm. long, obpyramidal, 4-sided, brown to black, hispid at the extreme base with hairs 0.1-0.3 mm. long, the upper portion nearly glabrous with only a few appressed hairs; pappus of 8(-9) broadly obovate scarious scales; scales 0.5-1.1 mm. long, 0.4-0.6 mm. wide, 1/2-2/3 the length of the tube, thickened at the base with the midrib extending about 1/2 the length of the scale. Chromosome number, $n = 11$.

DISTRIBUTION: A localized species restricted to moist igneous soils mostly along streams in canyons of Brewster, Jeff Davis and Presidio counties, Texas, 5000-6000 ft. (Fig. 53). Principal flowering dates June-October.

REPRESENTATIVE COLLECTIONS: TEXAS. BREWSTER CO.:

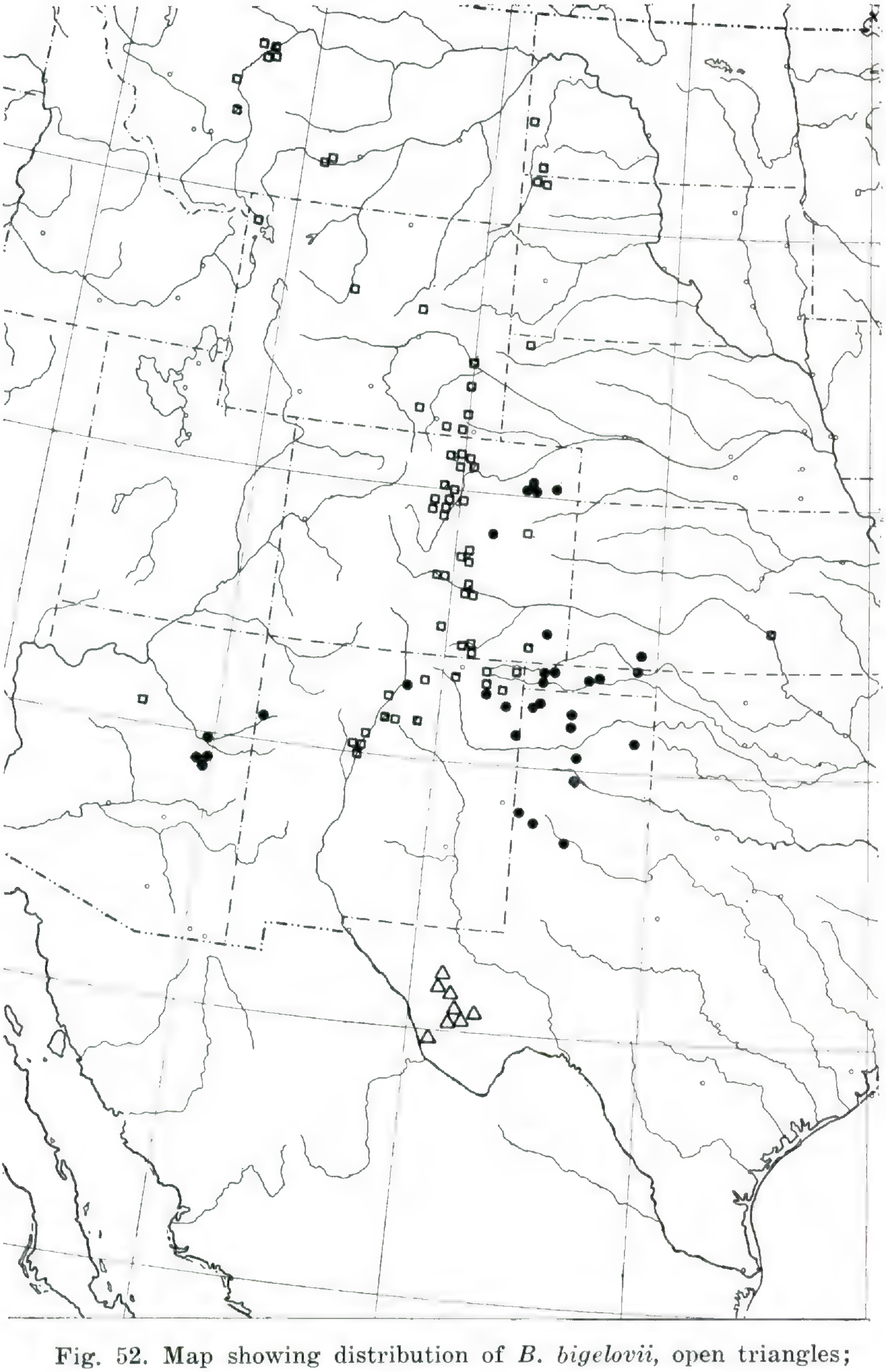

Fig. 52. Map showing distribution of *B. bigelovii,* open triangles; *B. oppositifolia,* open squares; *B. woodhousei,* closed circles.

Fig. 53. *B. bigelovii* (*Young s.n.*, UC). Entire plant, × 2/7. a. Head, × ca. 2. b. Ray floret, × ca. 4. c. Disc floret, × ca. 4. d. Pappus scale, × ca. 12. e. Style branches, × ca. 12.

Paisano Pass, Sept. 4-8, 1925, *B. C. Tharp 3777* (TEX, US). Alpine, McIntire Hill, Aug. 5, 1938, *B. H. Warnock T497* (TEX, US). JEFF DAVIS CO.: Mt. Livermore, Davis Mts., Oct. 19, 1935, *O. E. Sperry T371* (LL, US). Lower Fern Canyon N. of Alpine, Aug. 26, 1940, *B. H. Warnock W883* (ARIZ, GH, TEX). PRESIDIO CO.: Chinati Mt., Watts Ranch, 5000 ft., Aug. 27, 1943, *L. C. Hinckley 2838* (LL).

To be concluded

A NEW METHOD FOR MOUNTING EVERGREEN CONIFER TWIGS WITH DECIDUOUS LEAVES[1] — Twigs of *Tsuga* and *Picea* quickly lose their leaves when cut and dried; herbaria contain many sheets of species of these genera, on which are fastened bare twigs with accompanying packets of leaves. Using the old glass plate and paste method, I learned and described a technique which retained part of the leaves in place (Sharp, 1935).

Many herbaria have replaced the paste mounting medium with the plastic adhesive as described by Archer (1950) or some modification of it. I have found that fresh twigs of *Tsuga* and *Picea* may be mounted on the sheets with the plastic and a large percentage of the leaves retained if the nozzle of the "gun" is run along the twig placing the plastic at the bases of the leaves. The specimens look better unpressed although they occupy considerable space in the herbarium case. They may be pressed after drying but not without some breakage.

It may be of interest to note that, if specimens mounted with plastic are allowed to dry at room temperatures for three months, the sheets may be placed in herbarium cases with paradichlorbenzene without adhering to each other. During drying we store the exsiccatae in pasteboard boxes about the size of the shelves in the herbarium case.

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BIBLIOGRAPHY

ARCHER, W. ANDREW. 1950. New plastic aid in mounting herbarium specimens. Rhodora **52**: 298-299.

SHARP, A. J. 1935. An improvement in the method of preparing certain gymnosperms for the herbarium. Rhodora **37**: 267.

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[1]Contribution from the Botanical Laboratory, The University of Tennessee, N. Ser. 245.

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CONTENTS:

Marine Vegetation of Cape Ann, Essex County, Massachusetts.

I Seasonal Succession.

II The Occurring of the Genus Pantoneura Kylin (Rhodophyta) in North America
I. Mackenzie Lamb and Martin H. Zimmermann 217

Dryopteris goldiana x intermedia — A Natural Woodfern Cross of Noteworthy Morphology.
A. Murray Evans and W. H. Wagner, Jr. 255

A New Species of Ratibida (Compositae) from Mexico.
Edward L. Richards 267

(Continued on Inside Cover)

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CONTENTS: — *continued*

An Unusual Erianthus alopecuroides. *Albert Robinson, Jr.* 268

Microchromosomes in Aphanostephus (Compositae). *Edwin B. Smith and R. Roy Johnson* 270

Notes on Paspalum minus and Andropogon pertusus in the United States. *Donald J. Banks* 273

The Chromosome Number of Neviusia alabamensis. *Joab L. Thomas and Rebecca Deramus* 274

Micheliella verticillata in Ohio. *E. Lucy Braun* 275

A New Name in Deyeuxia. *A. A. Beetle* 277

Linum coahuilense, A New Species from Northern Mexico *C. Marvin Rogers* 278

Conobea multifida; A New Record for Nebraska. *Robert J. Lemaire* 280

A Systematic Study of the Genus Bahia (Compositae) *concluded. William L. Ellison* 281

Erigenia, A Genus New to Oklahoma. *Charles S. Wallis* 311

Rhodora

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MARINE VEGETATION OF CAPE ANN, ESSEX COUNTY, MASSACHUSETTS*

I Seasonal Succession
II The Occurring of the Genus Pantoneura Kylin (Rhodophyta) in North America

I. Mackenzie Lamb and Martin H. Zimmermann

Our observations have been made over a period of three years, at intervals of 1 - 2 weeks, at Pitcairn Park, Halibut Point, at the northernmost tip of Cape Ann, Essex County, Massachusetts. The sublittoral vegetation was studied *in situ* by means of SCUBA (Aqualung) diving techniques. The objectives of our study were (1) to make as complete as possible an inventory of all the species of marine algæ occurring within this limited area, and (2) to obtain information on their seasonal development.

Our knowledge of the seasonal development of the marine algæ of the north-east coastlines of North America is very deficient, due to the fact that collectors have tended to restrict their activities to the summer months. In the British Isles the first systematic attempt in this direction was made by Dawson Turner (1800), who published a "Calendarium Plantarum marinarum", "a list of the periods at which some of the British marine *Algae* produce their fructification." In this early paper lists of species, mostly from the east coast of England, were given for each month of the year, and the author remarks that "the habitation of many of these plants at the bottom of the ocean, remote from any

*Contribution from the Farlow Herbarium, Harvard University, Cambridge, Massachusetts.

shore, where we are of necessity precluded from all possibility of tracing them through their several stages of growth, is certainly one of the greatest obstacles to our procuring a clear and comprehensive knowledge of them. How far the difficulties arising from this circumstance can ever be entirely removed, time and experience must alone determine." A century later data on algal periodicity were published by Svedelius (1901), based on a series of winter dredgings in the Baltic Sea, and subsequent seasonal observations were made by Skottsberg (1907), Cotton (1912), Knight and Parke (1931), and Levring (1940). In this country, studies of a similar nature were made by Davis (1913), Howe (1914), and more recently by MacFarlane and Bell (1933). The latter paper, which deals with the algæ occurring near Halifax, Nova Scotia, contains a great deal of valuable information directly comparable with our own results.

I. The Marine Vegetation of Cape Ann and its Seasonal Variation

We will describe first, in a general way, the marine algal vegetation of Pitcairn Park which is, we believe, typical for all rocky exposed shores of northern Massachusetts, and follow this by a list of the species found there with remarks on seasonal development.

INTERTIDAL ZONE. At Pitcairn Park this consists of very large flat slabs of granite rock sloping down into the sea at an angle of approximately 20 degrees, and has only a few very shallow depressions in which water is caught at low tide. At the highest level of this zone rocks are kept wet by wave action only at high tides and during storms. Some rock surfaces are largely covered with the blue-green alga *Calothrix scopulorum*. This cover is most prominent during the winter months and less conspicuous in the summer. At the lower edge of the *Calothrix*-zone, immediately above the *Fucus vesiculous*-belt, patches of *Porphyra linearis* may appear in November, persist through the winter, and finally discolor and weather away in March; its occurrence, however, is irregular, and in some years it fails altogether to

Plate 1298. Vegetation of the upper sublittoral (circ. 2 m. below MLTL) at Pitcairn Park, Halibut Point, May 26, 1962. Upper picture: vertical rock to the left covered mainly with *Fucus edentatus;* on horizontal rock face (foreground) *Monostroma* sp. and weathered *Halosaccion ramentaceum.* Lower picture: center foreground, *Rhodymenia palmata* and *Halosaccion ramentaceum;* left and right, *Monostroma* sp.; left foreground in corner, *Alaria esculenta.*

appear. In March, similar places begin to become colonized by *Bangia fuscopurpurea,* which disappears again shortly thereafter. *Ulothrix flacca,* often in very stunted filaments, forms extensive, dark green stains over many of the rocks in the same area. *Fucus vesiculosus* and *Ascophyllum nodosum* are the most prominent occupants of the middle intertidal zone. They are regularly exposed during low tides and usually subject to considerable drying during that time. At the mean low tide level we find *Chondrus crispus* and *Gigartina stellata,* the latter usually in the more protected and wetter places. Extreme low spring tides expose the algæ of the sublittoral fringe zone, populated mainly by *Fucus edentatus;* these plants do not dry out but are always kept wet by wave action when exposed.

UPPER SUBLITTORAL ZONE (Plate 1298). In the upper sublittoral there are some deep pools or "kettles," partly accessible by wading during low spring tides, and these areas constitute by far the richest zone of vegetation, at least insofar as number of species is concerned. We find there large brown algæ like *Fucus edentatus, Saccorhiza dermatodea, Alaria esculenta, Chorda tomentosa,* smaller ones like *Scytosiphon lomentaria* and *Petalonia fascia,* red algæ like *Rhodymenia palmata* and *Halosaccion ramentaceum,* and numerous greens *(Chaetomorpha melagonium, Spongomorpha spinescens, Ulva lactuca, Monostroma* spp., etc.). One of the most significant aspects of this rich upper sublittoral zone is the rapid seasonal turnover of species. Every month some species appear and others weather away. It is obvious that further study will have to be devoted to this region before a complete description of its seasonal development becomes possible.

THE LAMINARIA-BELT (Plate 1299). The large kelp beds, consisting of *Laminaria agardhii, L. longicruris* and *L. digitata,* are the most striking vegetational feature of the rocky ocean floor to the casual diver. They extend from about 2 m below mean tide level to approximately 12 m depth. The upper limit is fairly sharply defined, and only occasional plants occur high enough up to show their fronds floating on the surface during low spring tides. Between 2 and 10 m

Plate 1299. The *Laminaria*-belt (middle sublittoral, circ. 6 m. below MLTL) at Pitcairn Park, Halibut Point, Sept. 22, 1962. Old *Laminaria*-stipes with profuse epiphytic growth of *Ceramium rubrum*.

depth the Laminarias grow quite densely so that relatively little light penetrates to the smaller plants on the rock underneath. Such smaller plants of this zone are *Chondrus crispus*, *Euthora cristata*, *Corallina officinalis*, and *Ahnfeltia plicata*. On old denuded *Laminaria*-stipes there is a rich growth of *Ceramium rubrum* and some other smaller red and brown algæ. *Pantoneura baerii*, to which special refer-

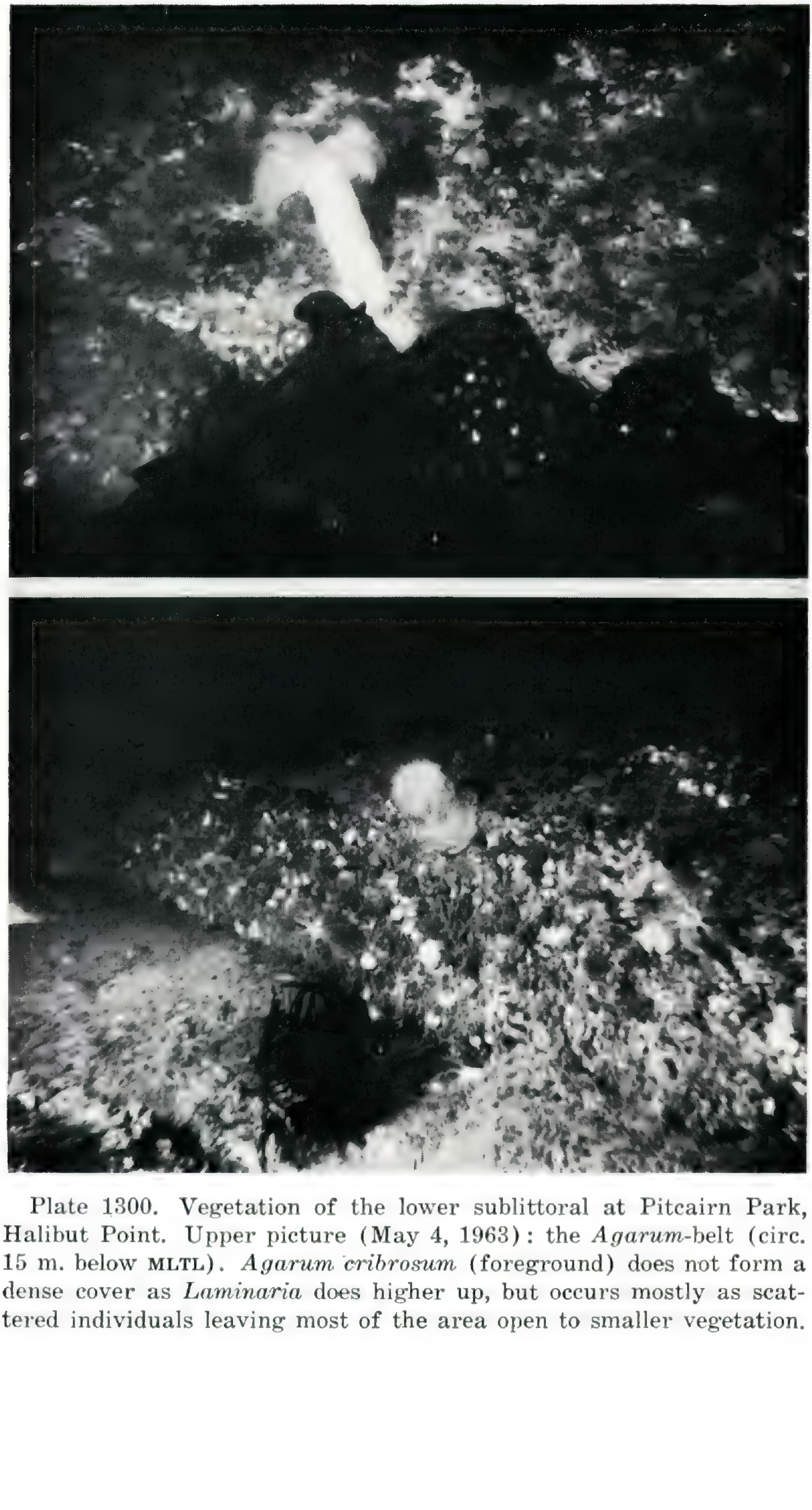

Plate 1300. Vegetation of the lower sublittoral at Pitcairn Park, Halibut Point. Upper picture (May 4, 1963): the *Agarum*-belt (circ. 15 m. below MLTL). *Agarum cribrosum* (foreground) does not form a dense cover as *Laminaria* does higher up, but occurs mostly as scattered individuals leaving most of the area open to smaller vegetation.

ence is made in the second part of this paper, is of relatively abundant occurrence at the lower edge of the *Laminaria*-belt, where it grows on coarser algæ such as *Chondrus*, *Phyllophora* and *Corallina;* in spite of its abundance, it is seldom found washed ashore, on account of its being out of reach of the most vigorous wave action.

THE AGARUM-BELT (Plate 1300, upper picture). Around 12 m depth the Laminarias are gradually replaced by *Agarum cribosum*. *Agarum* can be found between approximately 10 and 20 meters, but is most abundant between 12 and 16 meters, not forming, however, as dense a cover as the Laminarias further up. The smaller plants of this zone are *Chondrus crispus*, *Phyllophora brodiaei*, *Antithamnion* ssp., *Ptilota serrata*, and in silty crevices and floors between the rocks *Polyides caprinus*. Firmly attached clumps of the Horse Mussel (*Modiolus modiolus* L.) are usually extensively covered by pink or purplish patches of encrusting calcareous algæ *(Lithothamnium, Phymatolithon, Clathromorphum)*.

THE LOWER LIMIT OF VEGETATION (Plate 1300, lower picture). From about 16 m depth downwards, reckoned from mean low tide level, the vegetation begins to become appreciably thinner. The rock surfaces are mostly covered with fine gray silt. There are scattered plants of *Agarum cribrosum*, dwarfed *Phyllophora brodiaei*, and a thin form of *Rhodomela confervoides;* some of the encrusting calcareous red algæ also survive at this level. At about 20 meters depth the vegetation peters out completely.

VERTICAL DISTRIBUTION OF PLANTS. Many species, e.g., *Pantoneura baerii*, are limited to a well defined zone of depth, but others are not selective in this respect and cover

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Such smaller plants include *Phyllophora brodiaei, Pantoneura barii,* *Antithamnion* spp.; a large sea-anemone *(Metridium)* in center of the photograph. Lower picture (June 3, 1963): the lower limit of vegetation (circ. 20 m. below MLTL). The only plants growing here are small individuals of *Phyllophora brodiaei* (dark spots to left and rear right of *Metridium* in center of picture); the decaying *Alaria*-blade in center foreground has been drifted down from the upper sublittoral. The rocks are covered with very fine and easily disturbed gray silt, and are well colonized by Coelenterates, Bryozoa, Echinodermata and other forms of animal life.

a wide range, notably *Chondrus crispus*, which grows in abundance from the intertidal zone down to a depth of about 15 m below MLT level, becoming progressively darker reddish downwards. Another example of extreme depth range is *Rhodomela confervoides*, and it is interesting to note how its habitus changes with depth. In the upper sublittoral it is a robust, bushy plant with well defined fasciculate (penicillate) apices; it becomes more slender with increasing depth, and at 20 meters takes on a form (f. *gracilior*) which is more or less nonpenicillate and hardly recognizable as the same species.

The vertical distribution given for the algæ in the following list is in accordance with the nomenclature of Parke (1948). The *intertidal zone* lies between high water of extreme spring tides (HWEST) and low water of mean spring tides (LWMST). The *sublittoral fringe zone* lies between low water of mean spring tides and low water of extreme spring tides (LWEST). The *sublittoral zone* extends downwards from low water of extreme spring tides. Algæ in the intertidal zone are usually exposed at low tide; those in the sublittoral fringe zone are exposed only occasionally, and those in the sublittoral zone are never exposed. Depths in meters are reckoned from the mean low tide level (MLTL).

CYANOPHYTA

Calothrix scopulorum (Web. & Mohr) C.Ag. On flat, sloping rock face in upper and middle intertidal zone, forming extensive, blue-green, slippery patches. — Perennial, but best developed in the winter months.

Plectonema battersii Gom. Mixed in with the foregoing.

RHODOPHYTA

Ahnfeltia plicata (Huds.) Fr. On rocks in lower intertidal zone and upper to middle sublittoral. — Perennial.

Antithamnion boreale (Gobi) Kjellm. Attached to coarser algæ (*Chondrus*, etc.) or to horse mussels in sublittoral 7-15 m below MLTL. Often mixed with *A. floccosum*, which is much more abundant. — Seen in February and March.

Antithamnion floccosum (Müll.) Kleen. On rocks, stones and mussels (also on an old anchor) in sublittoral at 7-15 m below MLTL. — Abundant from January to April. MacFarlane and Bell (1933, p. 167) find it in the summer in Nova Scotia.

Asparagopsis hamifera (Hariot) Okam. Of rare occurrence in the sublittoral at 9-13 m below MLTL, attached to other algæ *(Chaetomorpha, Chondrus, Phyllophora)* either by its basal holdfasts or by its hamate branchlets. Only twice noted directly attached to rock. — Seen only in December, January and May at Pitcairn Park, but probably overlooked at other seasons, as we have found well developed plants at Brace's Cove, Gloucester, 4 miles distant, in summer and fall.

Bangia fuscopurpurea (Dillw.) Lyngbye. On flat, sloping rock faces in upper intertidal zone, among *Calothrix scopulorum,* forming patches up to 1 m across. — Appears quite suddenly about the beginning of March and persists into early summer, slowly disappearing during midsummer. This is in accordance with observations of Davis (1913, p. 813) at Woods Hole and Knight and Parke (1931, p. 76) in the British Isles, but contrasts with the development on Nova Scotia, where MacFarlane and Bell (1933, p. 167) have noted it to occur in winter and early spring.

Ceramium rubrum (Huds.) C.Ag. In the *Laminaria*-belt of the sublittoral, very abundant on the stipes of *Laminaria,* occasionally on other coarse algæ, e.g. *Rhodymenia.* — Perennial.

Chondrus crispus Stackh. Ubiquitous and very abundant on rocks in all zones from the lower intertidal down to the low sublittoral *(Agarum*-zone). Plants growing in the deep water are narrow-branched and very dark. — Perennial.

Clathromorphum circumscriptum (Stroemf.) Fosl. On shells of horse mussel *(Modiolus modiolus* L.) 12-16 m below MLTL, forming a minor constituent of their covering of encrusting calcareous corrallines, which is mainly composed of *Lithothamnium.* — Perennial.

Corallina officinalis L. On rocks in the upper sublittoral down to the base of the *Laminaria* zone, scattered. — Per-

ennial. New growth of tips observed to take place in late September.

Cystoclonium purpureum (Huds.) Batters. On rocks from the upper to lower sublittoral, 2-13 m below MLTL, common. — Seen from March to October. The var. *cirrhosum* Harv., with the branchlets forming coiled tendrils, is occasionally met with in our area, from June to October.

Euthora cristata (L. ex Turn.) J.Ag. Attached to stones and shells, and to stalks and remnants of coarser algæ in the sublittoral from 4 m downwards to about 14 m below MLTL, common. — New growth starts in January, plants attain their maximum size by March, and cystocarps and tetrasporangia are produced in April and May. The plants then persist into fall and winter without making any perceptible further growth.

Gigartina stellata (Stackh.) Batters. On rocks in the lower intertidal zone, interspersed and partly covered by other algæ *(Chondrus, Fucus, Ascophyllum)*. — Perennial.

Halosaccion ramentaceum (L.) J.Ag. On rocks in the upper sublittoral, about 2 m below MLTL, associated with *Chorda tomentosa, Alaria esculenta,* etc. — "Pseudoperennial" in the sense of Knight and Parke (1931), i.e., it persists by the basal portions, from which new thalli are produced annually. The thalli may be either simple or branched, and attain a length of 30 cm at their maximum development. — New thalli appear in February, and become fully grown in late March or early April; in early June they begin to become discolored from above downwards, and wear away towards the end of June, their place being taken over by *Chordaria flagelliformis.*

Hildebrandtia prototypus Nardo. In scattered patches on rocks in the lower intertidal. —Perennial.

Lithothamnium sp. Abundant on shells of horse mussel *(Modiolus modiolus* L.) 12-16 m below MLTL, forming purple, lumpy patches. — Perennial; sporangial conceptacles mature in winter (December-January).

Membranoptera alata (Huds.) Stackh. Epiphytic on *Laminaria, Phyllophora,* and *Chondrus* at about the 13 m depth

level, in small scattered colonies mixed with other algæ, such as *Ceramium rubrum* and *Euthora cristata;* not common. All the plants in our area are the very narrow form of the species. — Perennial. We have observed spermatangial plants in December and tetrasporic plants in January.

Pantoneura bearii (Postels & Rupr.) Kylin. Grows on coarser algæ *(Phyllophora, Chondrus,* more rarely *Laminaria)* at the junction of the *Laminaria*- and *Agarum*-zones in the lower sublittoral. Although constantly present, it does not grow in large quantities and is hence easily overlooked. — With us it appears to be a perennial, but from the remarks of Kjellman and Rosenvinge it appears probable that it may behave as an annual in the Arctic; see our remarks in the second section of this paper.

Phycodrus rubens (Huds.) Batters. Attached in tufts to rocks in the lower sublittoral (middle of *Laminaria*-belt down to *Agarum*-belt), abundant. — Perennial, or perhaps biennial, according to Taylor, 1957, p. 323, but becoming very worn and ragged in the winter months. There is no marked seasonal cycle in reproduction, but tetrasporic individuals are more common in winter and cystocarpic plants are more frequently found in summer.

Phyllophora brodiaei (Turn.) J.Ag. In tufts on rocks in the middle to lower sublittoral (6-20 m below MLTL), becoming stunted at the deepest stations which are at the lower limit of algal vegetation. — Perennial, but has a marked surge of new growth in January, with formation of new fronds from the tips of the old ones. The globose tetrasporic nemathecia *("Actinococcus subcutaneus")* are not frequently produced; we have seen them in April and September.

Phymatolithon laevigatum (Fosl.) Fosl. Occasional on shells of horse mussel 12-16 m below MLTL, forming a minor constituent of their covering of encrusting calcareous corallines, which is mainly composed of *Lithothamnium.* — Perennial.

Polyides caprinus (Gunner.) Papenf. Extends from the middle to the lowest sublittoral, growing either on rocks or

on the silty floor. — Perennial. The pale, tumor-like cystocarps have been seen in November.

Polysiphonia flexicaulis (Harv.) Collins. In large soft tufts attached to coarser algæ *(Chondrus,* blades of *Laminaria* in the *Laminaria*-zone, 6-7 m below MLTL. — Annual; appears suddenly in mid-August and lasts only about 2 weeks, during which time both generations are produced; it is monoecious, spermatangia and cystocarps being present on the same plants.

Polysiphonia lanosa (L.) Tandy. Abundant on *Ascophyllum* in the lower intertidal zone. — Perennial.

Polysiphonia nigrescens (Huds.) Grev. Rare, found twice in the *Laminaria*-belt at about 7 m depth, attached to rock. — Seen only in November, as old plants going into winter condition, with the trichoblasts fallen off and a fair amount of cortication developed on the main branches. MacFarlane and Bell (1933, p. 173) found it common at all seasons in Nova Scotia.

Polysiphonia urceolata (Lightf.) Grev. On rocks in the sublittoral fringe zone, about 1 m below MLTL, abundant in one particular place. — Perennial. We have observed cystocarpic and tetrasporic plants growing intermixed in December, and spermatangial plants in February.

Porphyra linearis Grev. On flat, sloping rock face in mid-intertidal zone, among *Calothrix scopulorum,* gregarious, numerous individual thalli. — In 1962 it appeared at the beginning of November, and throve through the winter until early March 1963, when it began to discolor and deteriorate, finally rotting away at the end of March. In the winter of 1963-64, however, it failed to appear. This species has been regarded by some workers (Taylor 1937, p. 222, 1962, p. 207; Rees, 1940) as a form or juvenile state of *P. umbilicalis;* others, such as Kylin (1944, p. 11; Kornmann, 1961, p. 177), consider it to be a well defined species, differing from *P. umbilicalis* in its morphology, ecology and seasonality. It may of course be questioned whether our North American plants are identical with the European *P. linearis,* which was first described by Greville from the British Isles; we

have not made a comparative study of the anatomy and reproductive development. However, our Massachusetts plants show the characteristic morphology of the European species, well shown in Fig. 1 of Kormann's paper (op.cit.).

Porphyra miniata (Lyngbye) C.Ag. Attached to other algæ *(Chondrus,* etc.) on rocks in upper sublittoral, 1-2 m below MLTL, fine large plants, occasional. — A summer annual, found here only in June and July.

Porphyra umbilicalis (L.) J.Ag. On rocks in upper sublittoral about 1 m below MLTL, scattered plants. — Can be found from early spring to late fall.

Ptilota serrata Kütz. Epiphytic on other algæ *(Corallina*-stumps, *Laminaria*- stipes) in the lower sublittoral, 9-15 m below MLTL, fairly frequent but not abundant. — Perennial. Said by Taylor (1962, p. 307) to fruit in summer; we have never seen cystocarpic plants, but have collected specimens with tetrasporangia in December and January.

Rhodomela confervoides (Huds.) Silva (syn. *Rh. subfusca* (Woodw.) C.Ag.). The typical form, of robust growth with strongly penicillate end-branchlets, grows in the upper sublittoral and sublittoral fringe zone and is in good condition only in the spring, becoming heavily epiphytized by diatoms and degenerating by early summer; the deep water form (f. *gracilior* (J.Ag.) Tayl.), which occurs in the *Laminaria*- and *Agarum*-zones, remains in good condition at all seasons; it is very dissimilar to the typical form in aspect, being more slender and not markedly penicillate at the tips. We hope to perform transplantation experiments with a view to finding out whether it is a genetic entity or merely a deep water ecotype of the species.

Rhodymenia palmata (L.) Grev. Usually epiphytic on stalks of *Laminaria* between 2 and 12 meters depth, but can also occur directly on rock or on other coarser algæ e.g. *Fucus edentatus,* at any level from the sublittoral fringe zone to the middle sublittoral. — Perennial; fruits (tetrasporangia) in winter.

Trailliella intricata (J.Ag.) Batters. Abundant in small, compact, puff-like tufts attached gregariously to rocks and

to other algæ (*Chaetomorpha*, stumps of Corallina, etc.) in the *Laminaria*-zone, 5-10 m below MLTL; also grows frequently on the carapace and limbs of small spider crabs, which live at the same level among the Laminarias. As is well known, this species is almost certainly the tetrasporophyte generation of *Asparagopsis hamifera* (Hariot) Okam. We have never found it producing tetrasporangia, and according to Taylor (1962, p. 292) these have not been seen in our area. — Although Knight and Parke (1931, p. 92) regard this as probably an annual in the British Isles, we find it to be perennial in our area.

PHÆOPHYTA

Agarum cribrosum (Mertens) Bory. On rocks between 10 and 20 m below MLTL, forming a main zone between 12 and 16 m, but the plants are somewhat scattered. — Perennial.

Alaria esculenta (L.) Grev. In the upper sublittoral zone (top of the *Laminaria*-belt), gregarious and abundant. — Appears to be a biennial or a perennial of limited duration, with new generations of young plants formed every spring. In April to May at least three distinct age-groups of plants can be distinguished, presumably approximately one month, one year, and two years of age respectively.

Ascophyllum nodosum (L.) LeJolis. On rocks in the middle to lower intertidal zone, with *Fucus vesiculosus*, abundant. — Perennial, fruiting in May and June.

Chorda tomentosa Lyngbye. In upper sublittoral zone, associated with *Alaria esculenta*, *Halosaccion ramentaceum*, etc. — A spring annual, appearing in March and persisting till midsummer. In best condition in early May; by early June it begins to lose its covering of chromatophorous hairs, and these are all shed by the end of June, at which time the plants can be easily mistaken for *Ch. filum*.

Chordaria flagelliformis (Müll.) C.Ag. In upper sublittoral, interspersed in the zone of *Alaria*, *Chorda* and *Halosaccion*. — Annual, appearing about April, increasing until late July (at which time it tends to replace the disappearing

Halosaccion ramentaceum), and gradually thinning out in late summer; some individuals however are still persisting in October.

Desmarestia aculeata (L.) Lamour. In upper sublittoral, 6-8 m below MLTL, attached in large lax tufts to stones or rocks, or sometimes lying unattached. — Perennial (or perhaps biennial), overwintering by the old, dark, wiry branches; in early spring it puts out young pale assimilative shoots. By late summer these again disappear.

Desmarestia viridis (Müll.) Lamour. In same position as the foregoing, but less common, only occasional plants seen. — Annual; seen by us in May.

Ectocarpus tomentosoides Farlow. Common on stipes of *Laminaria*, forming a continuous, fur-like growth. — Perennial, in best vegetative condition in early spring; at other times of year it is heavily infested with diatoms. Plurilocular sporangia, liberating swarmers, seen by us in March.

Elachistea fucicola (Velley) Aresch. Epiphytic on *Fucus edentatus* in the uppermost sublittoral and sublittoral fringe zone, common. — Perennial, or perhaps to be regarded as pseudoperennial, as the assimilative filaments are mostly shed in winter.

Fucus edentatus De la Pyl. Forming a dense zone on the rocks in the sublittoral fringe zone and uppermost sublittoral. — Perennial. The reproductive receptacles attain full maturity in March.

Fucus vesiculosis L. Forming an association with *Ascophyllum* in the lower intertidal zone. — Perennial, with active reproduction in the winter and early spring, although receptacles are present all the year round.

Laminaria agardhii Kjellm. The dominant species in the *Laminaria*-belt between 2 and 13 meters below MLTL. — According to our observations this is a perennial of several years duration, with young plants appearing every spring, about April. At that time one can distinguish what seems to be three or four yearly age-groups in the population, ranging from the current year's generation (small, delicate plants 20 to 30 cm long) to denuded stipes which represent the

final stages of plants probably 3 or 4 years old. MacFarlane and Bell (1933, p. 163) report this species to behave as an annual or a pseudo-perennial in Nova Scotia.

Laminaria digitata (L.) Lamour. Scattered plants occur throughout the *Laminaria*-belt, showing great variation in the degree of segmentation of the frond — Perennial.

Laminaria longicruris De la Pyl. Occasional individuals among the *L. agardhii* population. Unless the stipes are characteristically developed (long, arcuate and swollen, manifestly hollow) it is almost impossible to distinguish this species from *L. argardhii* in situ. — Apparently perennial.

Leathesia difformis (L.) Aresch. Attached to *Chondrus crispus* and other algæ in the sublittoral fringe zone, not common. — Annual, in good condition in July.

Petalonia fascia (Müll.) Kuntze. Attached to very small mussels *(Mytilus)* covering the rocks in parts of the sublittoral fringe zone and upper sublittoral, fairly frequent in scattered tufts. — According to Skottsberg (1907, p. 155) this and the following species behave as winter annuals on the west coast of Sweden, but grow all the year round in the Arctic. In our area *Petalonia fascia* is perennial.

Punctaria plantaginea (Roth) Grev. Attached to rock in same zone as the foregoing, uncommon. — Annual, or perhaps pseudo-perennial according to Knight and Parke (1931, p. 58). Seen by us in March.

Pylaiella littoralis (L.) Kjellm. Epiphytic on *Fucus edentatus* in the sublittoral fringe zone and uppermost sublittoral not uncommon. — Apparently perennial, in best condition in spring and early summer. Unilocular sporangia seen by us in March, plurilocular sporangia in May.

Ralfsia fungiformis (Gunner.) Setchell and Gardner. On flat rock face in the sublittoral fringe zone, scattered thalli. — Perennial.

Saccorhiza dermatodea (De la Pyl.) Farlow. Rather rare at the uppermost edge of the *Laminaria*-zone, about 2 m below MLTL. — An annual according to Taylor (1962, p. 177), but MacFarlane and Bell (1933, p. 165/66) report it to persist at all seasons in Nova Scotia. In our area it has been

observed from the beginning of April (young plants) to the end of July.

Scytosiphon lomentaria (Lyngbye) C.Ag. On rocks in the sublittoral fringe zone and upper sublittoral, occasional. — There is some uncertainty as to whether this species should be classed as an annual, a perennial, or a pseudo-perennial (persisting by basal parts or as stunted individuals). Skottsberg (1907, p. 155) states that on the west coast of Sweden it is a winter annual, but in the Arctic regions is perennial. Seen by us in March.

CHLOROPHYTA

Chaetomorpha atrovirens Tayl. In the *Laminaria*-zone of the sublittoral, 6-12 m below MLTL, entangled among *Chondrus crispus*, occasional. — This is definitely a perennial in our area.

Chaetomorpha linum (Müll.) Kütz. Same occurrence as foregoing, not uncommon. — Perennial. Knight and Parke (1931, p. 51) report it to be an annual in the British Isles.

Chaetomorpha melagonium (Web. & Mohr) Kütz. Attached to rocks in the upper sublittoral, 3-5 m below MLTL, abundant. — Perennial.

Enteromorpha linza (L.) J.Ag. On surface of flat rocks in the lower intertidal zone, abundant. Perennial or pseudo-perennial; only stunted plants in winter, proliferating into large typical thalli in spring and summer.

Monostroma oxyspermum (Kütz) Doty. In the upper sublittoral (upper edge of the *Laminaria*-belt), attached to rocks, gregarious, locally abundant. — An annual, first appearing in March, and persisting to midsummer.

Monostroma pulchrum Farlow. Same data as for the foregoing species.

Spongomorpha arcta (Dillw.) Kütz. Growing in tufts on rocks in the sublittoral fringe zone, locally abundant. — Perennial or pseudo-perennial, with a marked surge of growth in February and March. From late summer till towards the end of the winter it is reduced and little obvious.

Spongomorpha spinescens Kütz. On rocks in lowest inter-

tidal zone, sublittoral fringe, and upper sublittoral, locally abundant. — In our area we have seen it only in spring and early summer (April-July).

Ulothrix flacca (Dillw.) Thuret. Forming widespread, effuse, dark green stains on sloping granite rocks in the upper intertidal zone, in most places in a very stunted condition, with short filaments barely visible to the unaided eye. — Perennial.

Ulva lactuca L. On rocks in uppermost sublittoral, by the upper edge of the *Laminaria*-zone, fairly common. — Perennial.

Urospora wormskjoldii (Mert.) Rosenv. Forming a continuous sward over the upper surface of a large boulder in the lowest intertidal zone, approximately at MLTL. — Apparently a spring and summer annual, seen by us only in April and May. Search has been made at various seasons for the *Codiolum* stage in the intertidal zone, but so far without success.

II. The Genus Pantoneura Kylin (Rhodophycophyta, Delesseriaceæ) in North America

Pantoneura Kylin was established in Kylin and Skottsberg, 1919 p. 47, and based on *P. plocamioides* Kylin, a subantarctic species from South Georgia. Its chief distinguishing character from the closely related genus *Membranoptera* resides in the fact that the thallus is almost entirely polystromatic, without a monostromatic lateral fringe (Kylin, 1956, p. 402, 428), and therefore homologous with the axial nerve or midrib of other members of the Delesseriaceæ. This distinction, as thus stated, requires some qualifications, and is discussed further below. Kylin pointed out the close relationship of the type-species, *P. plocamioides*, to the Arctic *Delesseria baerii* (Post and Rupr.) Rupr., and although he did not there transfer the latter to the genus *Pantoneura*, he prepared the diagnosis of the latter so that it could accommodate *D. baerii* (Kylin and Skottsberg, op. cit., p. 47, 51). Five years later Kylin (1924, p. 18) formally transferred *Delesseria baerii*, as well as four other species, to

Pantoneura, the genus therefore now including the following six representatives:

1. *Pantoneura plocamioides* Kylin in Kylin and Skottsberg, 1919, p. 47 (type species). — Subantarctic regions (South Georgia).
2. *Pantoneura rostrata* (Lyngbye) Kylin, 1924, p. 18. Basionym: *Gigartina purpurascens* γ. *rostrata* Lyngbye, 1819, p. 46 — Originally described from Greenland.
3. *Pantoneura baerii* (Rupr.) Kylin, 1924, p. 18. Basionym: *Delesseria baerii* Rupr., 1851, p. 239. *(Rhodomenia baerii* Post and Rupr., 1840, p. II, III, was a *nomen nudum.)* — Originally described from Russian Lapland.
4. *Pantoneura corymbosa* (J.Ag.) Kylin, 1924, p. 18. Basionym: *Delesseria corymbosa* J.Ag., 1852, p. 684. — Originally described from Greenland.
5. *Pantoneura angustissima* (Turn.) Kylin, 1924, p. 18. — Basionym: *Fucus alatus* γ. *angustissimus* Turner, 1811, Pl. 160, figs. k, l. — Originally described from the British Isles.
6. *Pantoneura juergensii* (J.Ag.) Kylin, 1924, p. 18. Basionym: *Rhodomenia juergensii* J.Ag., 1841, p. 14. — Originally described from Kamtchatka.

Two of the above species, *P. baerii* and *P. angustissima*, have been recorded from North America (see Taylor, 1937, p. 346, 1962, p. 320), and it is with these that we are concerned in the present context. According to Taylor's manual both are Arctic species, only *P. angustissima* being recorded from the United States coastline (northern Massachusetts), and that with some doubt.

The present authors first discovered *P. baerii* off Cape Ann, Essex County, northern Massachusetts, in 1961, and have since found it regularly in this locality at various seasons of the year; as mentioned in the preceding part of this paper, it occurs in the sublittoral on coarser algæ *(Phyllophora, Chondrus,* etc.). All reproductive stages

(spermatangial, cystocarpic and tetrasporic) have been found. Our original determination was kindly confirmed by Professor Taylor, who compared our material with specimens of *P. baerii* from Novaya Zemlya collected by Kjellman in 1875. This collection from Cape Ann represented the first recorded occurrence of the species from the United States. In point of fact, however, as will be shown below, *P. baerii* had been collected previously off Cape Ann, prior to 1903, but had been misidentified as *Delesseria angustissima.*

An attempt has been made to distinguish the two species on the basis of the shape of the branchlet tips: acute in *P. baerii,* obtuse in *P. angustissima* (Taylor, 1937, p. 346, 1962, p. 320). This is, however, not a good distinguishing character, for both species have moderately acute branch-tips in the normal growth condition; obtuse tips, which occur occasionally in both species, are probably the result of mechanical injury followed by varying degrees of regeneration, and it has also been noted that in *P. baerii* the tips of tetrasporic plants bearing sporangia are more obtuse than those of sterile or cystocarpic individuals. Both Harvey (1846-51, Pl. LXXXIII) and Kützing (1866, Pl. 16) illustrate the branch-tips of *P. angustissima* as moderately acute, as they are seen to be also in British specimens preserved in the Farlow Herbarium. Suggestions concerning the separation of the two species on other characters are not lacking in the older literature. Thus Ruprecht (1851, pp. 239-250) points out that *baerii,* in addition to being more slender than *angustissima,* differs in the size and form of the cells visible on the surface of the frond, having the cells of the middle line longer and rectangular, whereas in *angustissima* all the cells are small, rounded, close-set and uniform. The same difference is also described, in other words, by De-Toni (1897, p. 711). We have been able to confirm this distinction between the two species. Another alleged difference noted by Ruprecht, *loc. cit.*, is in the disposition of cystocarps and tetrasporangia: produced in the ends of ordinary branches in *baerii,* but on special short axillary branchlets in *angustissima.* This is certainly as stated in *Pantoneura baerii,* but

Fig. 4. *Pantoneura angustissima.* Outline of branch-apices with tetrasporangia. (Specimen in Farlow Herbarium from Scotland, Aberdeen, coll.?, 1844, ex herb. Abbie Davis.)

we cannot confirm the feature attributed to *P. angustissima*, at least insofar as tetrasporangia are concerned, for in a Scottish specimen of *P. angustissima* from Aberdeen in the Farlow Herbarium the spores are borne in the terminal segments of ordinary apical branches (Fig. 4), as illustrated also by Newton (1931, p. 318, fig. 194).

P. angustissima is certainly a more robust plant than *P. baerii;* according to the original description (Turner, 1811), "it sometimes rises to the height of more than nine inches." *P. baerii* may sometimes attain somewhat over six inches (circa 16 cm), but appears to be constantly more slender, with the main axis usually less than 1 mm in diameter, whereas the stem of *P. angustissima* often exceeds 1 mm down near the base. The largest plants of *P. baerii* seen by us belong to a suite of specimens collected by Dr. R. T. Wilce in Quebec, Ungava Bay, near the mouths of False River Bay and Koksoak River, in August 1954 and July and September 1955; most of them attaining 16 cm in length, and Dr. Wilce has informed us *in litt.* that his field studies led him to believe that these Ungava populations might have the growth-potential of *P. angustissima.* Specimens collected by ourselves in Massachusetts vary from 3 to 9 cm in length and 0.5 to 0.7 mm in thickness of main axis.

In *Pantoneura baerii* a superficial view of the apical branches shows more or less distinct, longitudinally elongated cells running down the middle of the frond, and larger than the approximately isodiametric cells of the lateral parts (Pl. 1301; fig. 1 A, C)*; in *P. angustissima* this superfical differentiation is completely lacking, the surface cells of the younger branches being all uniform, rounded and more or less isodiametric (Fig. 5 A). These elongated midrib-cells of *P. baerii* resemble those of *Membranoptera alata,* but do not produce the lateral spurs (veinlets) usually present in the latter (compare Fig. 3 A).

This key distinction between two Pantoneura species

*The drawings representing tissues of *P. baerii* in the living condition were made by tracing over projections of photomicrographs made from freshly gathered living material.

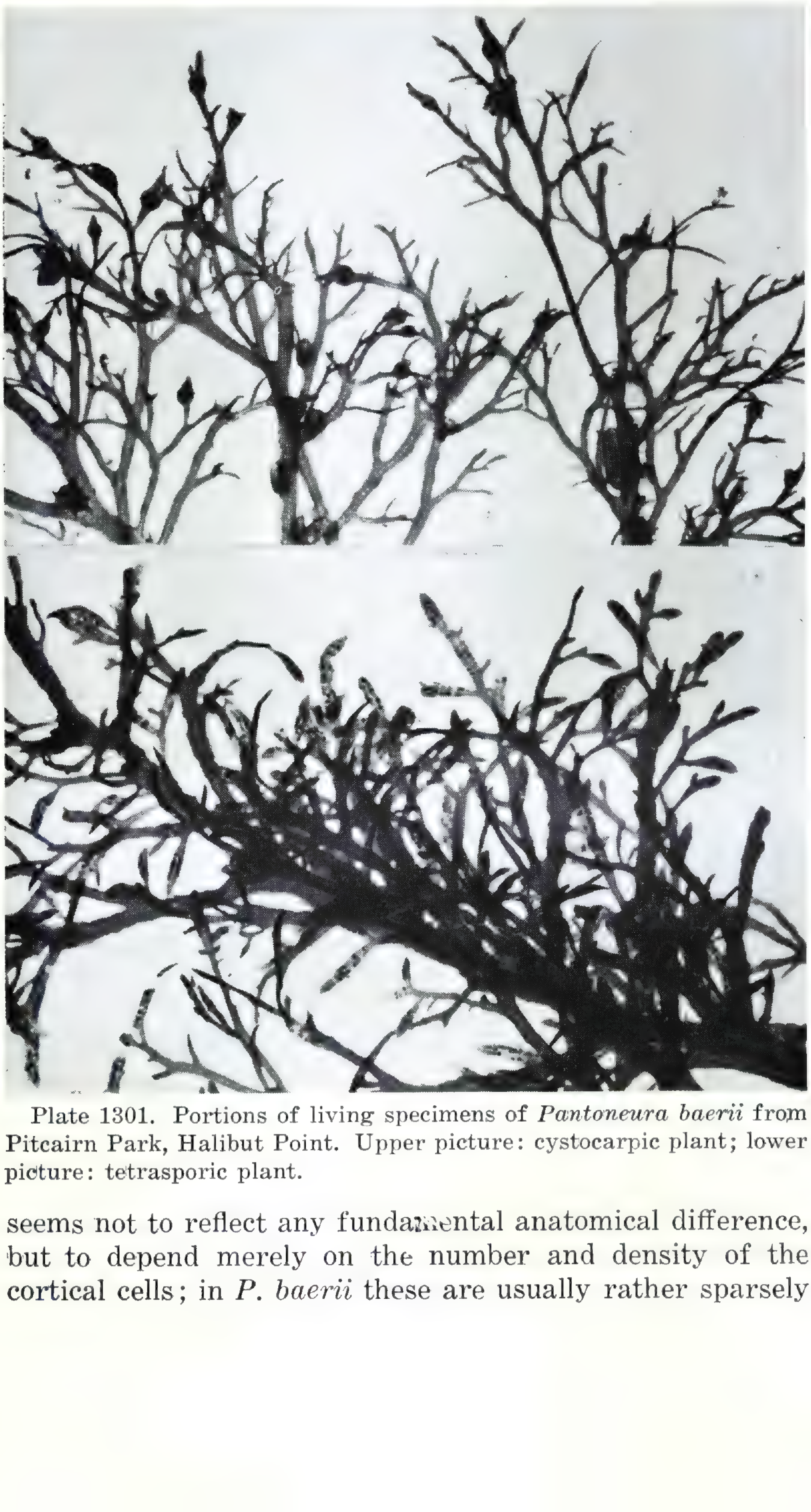

Plate 1301. Portions of living specimens of *Pantoneura baerii* from Pitcairn Park, Halibut Point. Upper picture: cystocarpic plant; lower picture: tetrasporic plant.

seems not to reflect any fundamental anatomical difference, but to depend merely on the number and density of the cortical cells; in *P. baerii* these are usually rather sparsely

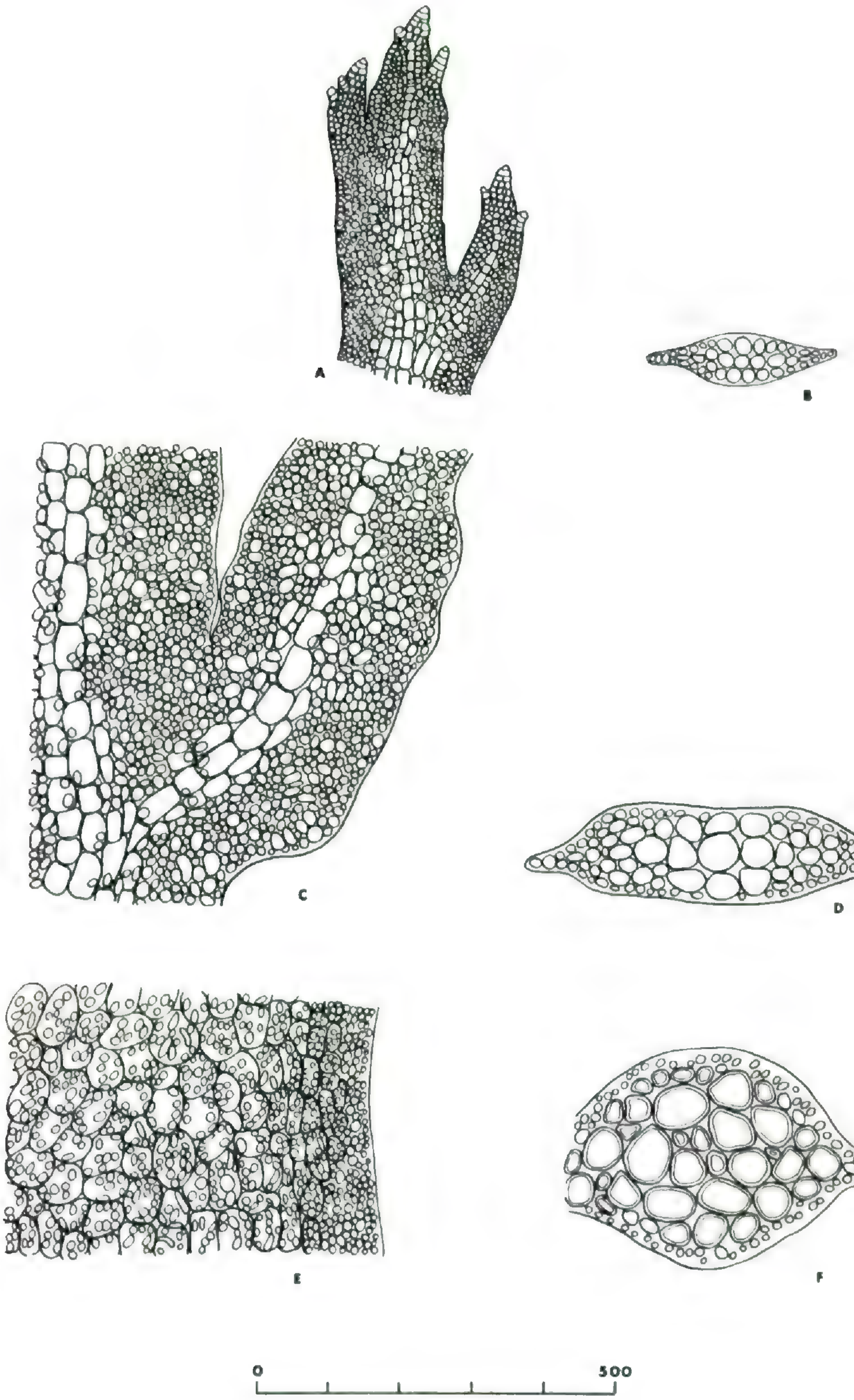

Fig. 1. Surface view of brances of *Pantoneura baerii* in living condition, with transverse sections at corresponding levels. A, B: branch-apex; C, D: about 5 mm. below tip; E, F: about half way down the plant. (Specimens from Pitcairn Park, Halibut Point, coll. Lamb and Zimmermann, 1963.)

developed over the midrib, as they are likewise in *Membranoptera alata* (compare Fig. 1C and Kylin, 1956, p. 401, fig. 315), whereas in *P. angustissima* they are densely crowded and, in conjunction with the more numerous outer medullary cells of the stouter thallus, effectively obscure the axial and lateral pericentral cell-rows from surface view. There is considerable variation in the development of cortical cells in *P. baerii,* from relatively numerous to lacking or almost so, and they are always scanty or absent in the apical parts of the branches.

As stated above, the view that the thallus of *Pantoneura* represents in effect nothing but the midrib of the foliose Delesseriaceous thallus requires some qualification. Although a lateral membranous marginal flange, which is such a conspicuous feature of *Membranoptera alata,* is never obvious, nevertheless it is usually distinctly developed, though narrow, on one or both sides of the upper complanate branches, both in *P. baerii* and *P angustissima.* In *Membranoptera* this marginal flange is entirely monostromatic (Fig. 3B) ; in the *Pantoneura* species examined it is mainly tri- or apparently distromatic, a monostromatic condition

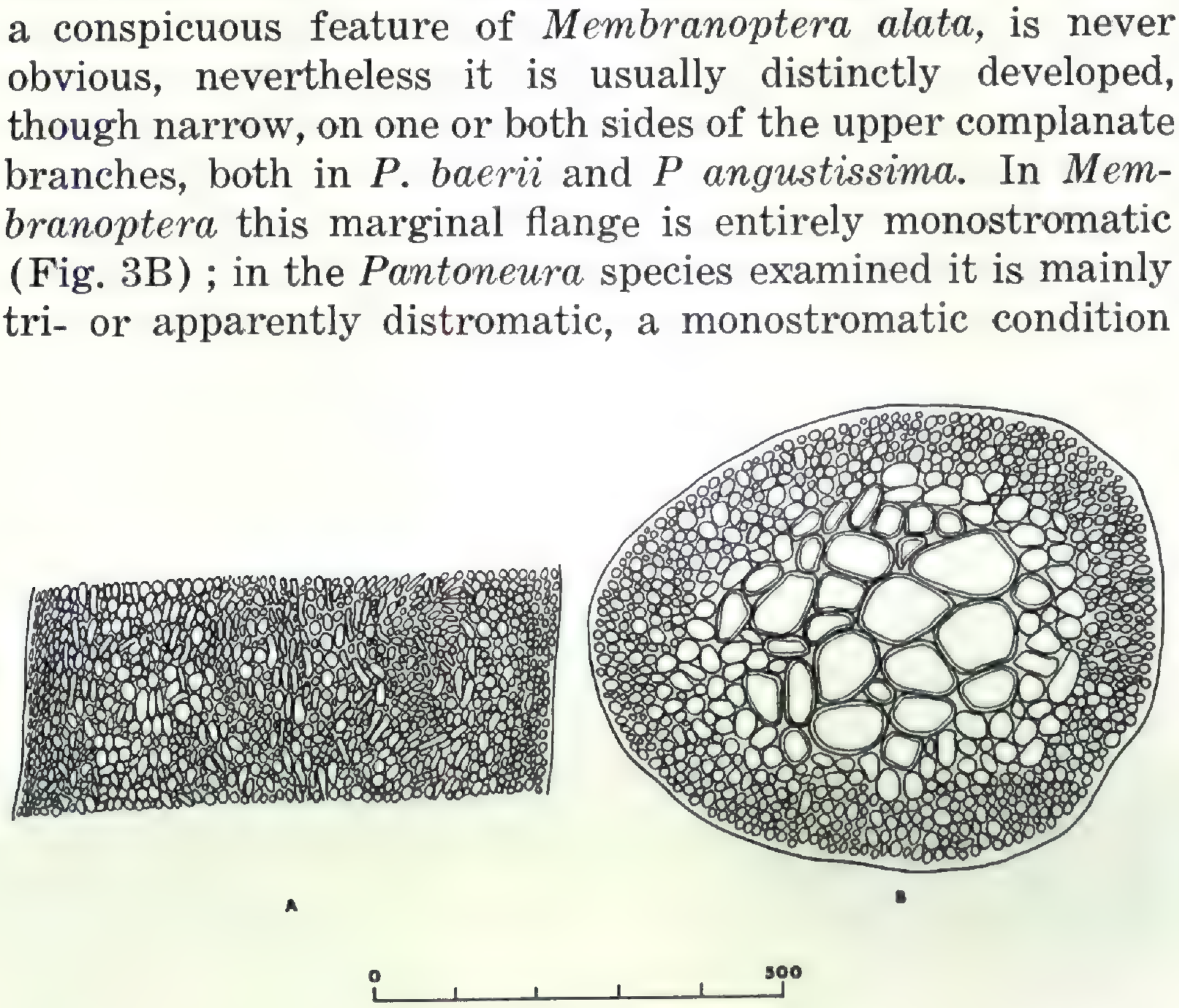

Fig. 2. Surface view (A) and corresponding transverse section (B) of main stem of *Pantoneura baerii* in living condition, from down near the base, circ. 5 mm. above the holdfast. (Specimen from Pitcairn Park, Halbiut Point, coll. Lamb and Zimmermann, 1963.)

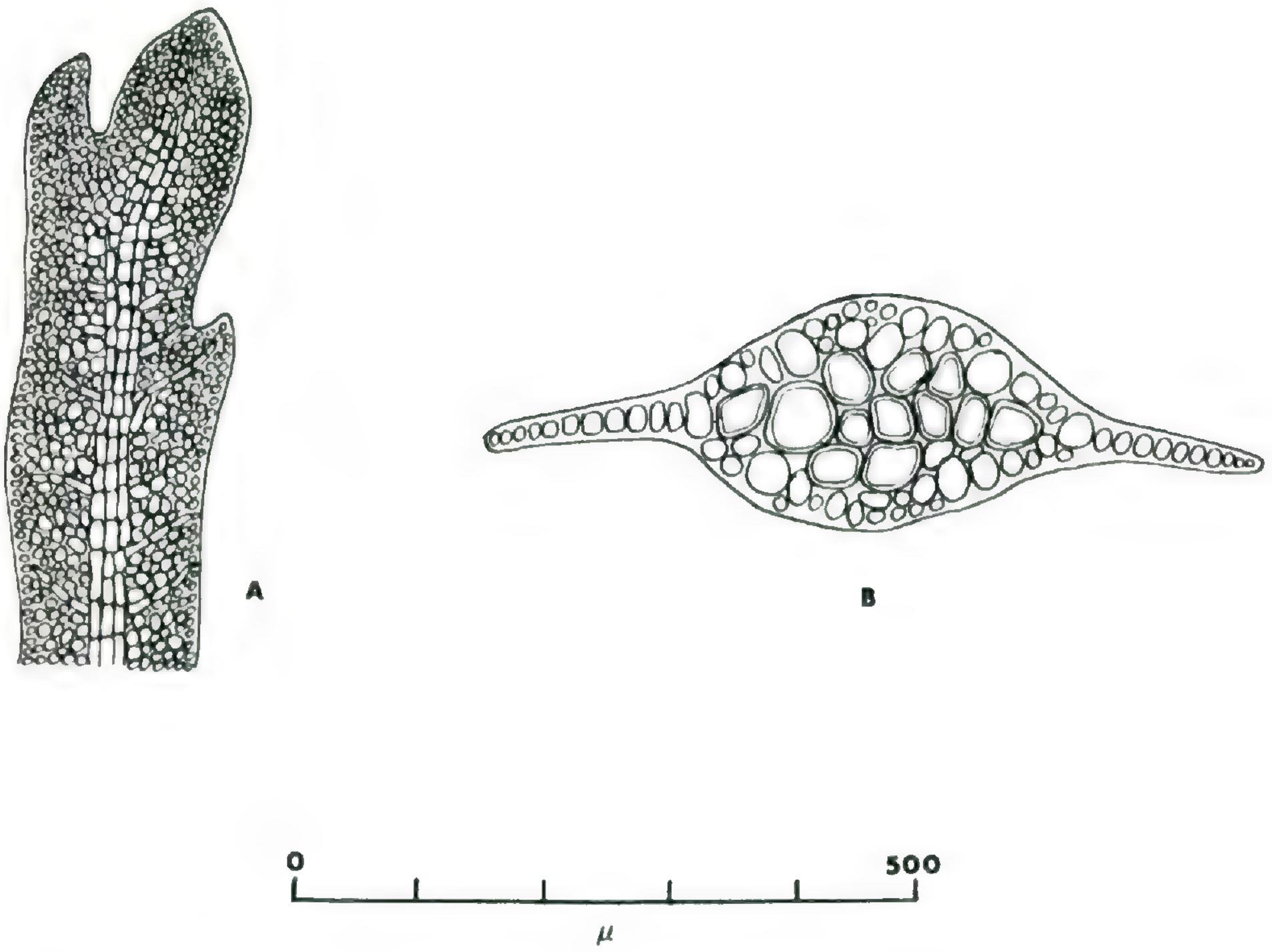

Fig. 3. *Membranoptera alata* (narrow form). A: branch-apex; B: transverse section of main branch about half way down the plant. (Specimen in Farlow Herbarium from Swampscott, Massachusetts, coll. F. Collins, 1878, *s. n.* "*Delesseria alata* var. *angustissima.*")

prevailing only in the outermost 2 to 6 cell-series or in young developmental stages near the branch-apices. Harvey (1846-51, Pl. LXXXIII, figs. 8, 9) was therefore substantially correct in illustrating the lateral alæ of *P. angustissima* as consisting of two layers of cells in transverse section.

The essential anatomical difference between the genera *Membranoptera* and *Pantoneura* seems to reside in the extent of the formation of cortical cells, which are produced dorsally and ventrally from the axial pericentral cells and from the laterally-running cell-rows of the second and third order; in the former genus such cortication is restricted to the midrib (immediate region of the axial cell-row and neighboring pericentrals), while in *Pantoneura* it is developed also from most of the cells forming the lateral flange, which structurally therefore is mainly tristromatic in section, except at the extreme edge, where cortical cells are not

produced. Transverse sections (Figs. 1 D, F; 6) usually show a tristromatic condition adjoining the midrib, a single cell layer in the outermost part, and in between what appears to be a distromatic condition, but which in our interpretation is derived from reduction in size of the primary cell to the point where it becomes more or less concealed between

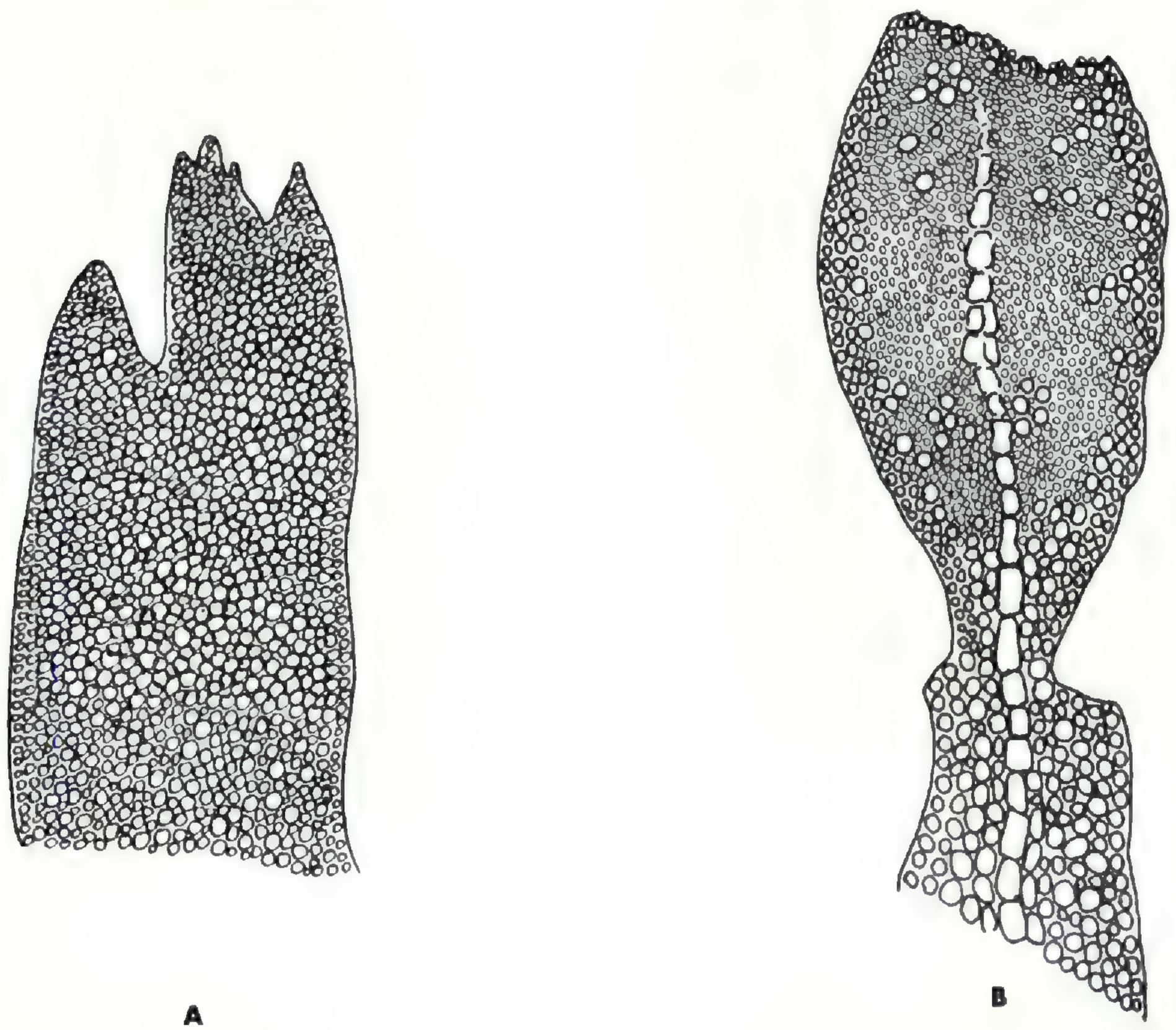

Fig. 5. A: surface view of branch-apex of *Pantoneura angustissima*. (Specimen in Farlow Herbarium from England, Scarborough, coll. Miss Jackson, date?.) B: spermatangial branch-apex of *Pantoneura baerii* in living condition. (Specimen from Pitcairn Park, Halibut Point, coll. Lamb and Zimmermann, 1964.)

its two cortical daughter-cells; occasionally it can be distinctly seen in sections (Fig. 6). The extreme condition to which this tendency gives rise is exemplified by the subantarctic genus *Microrhinus* Skottsb., in which the entire expanse of the thallus-membrane is corticated (Kylin, 1956, p. 402, 433).

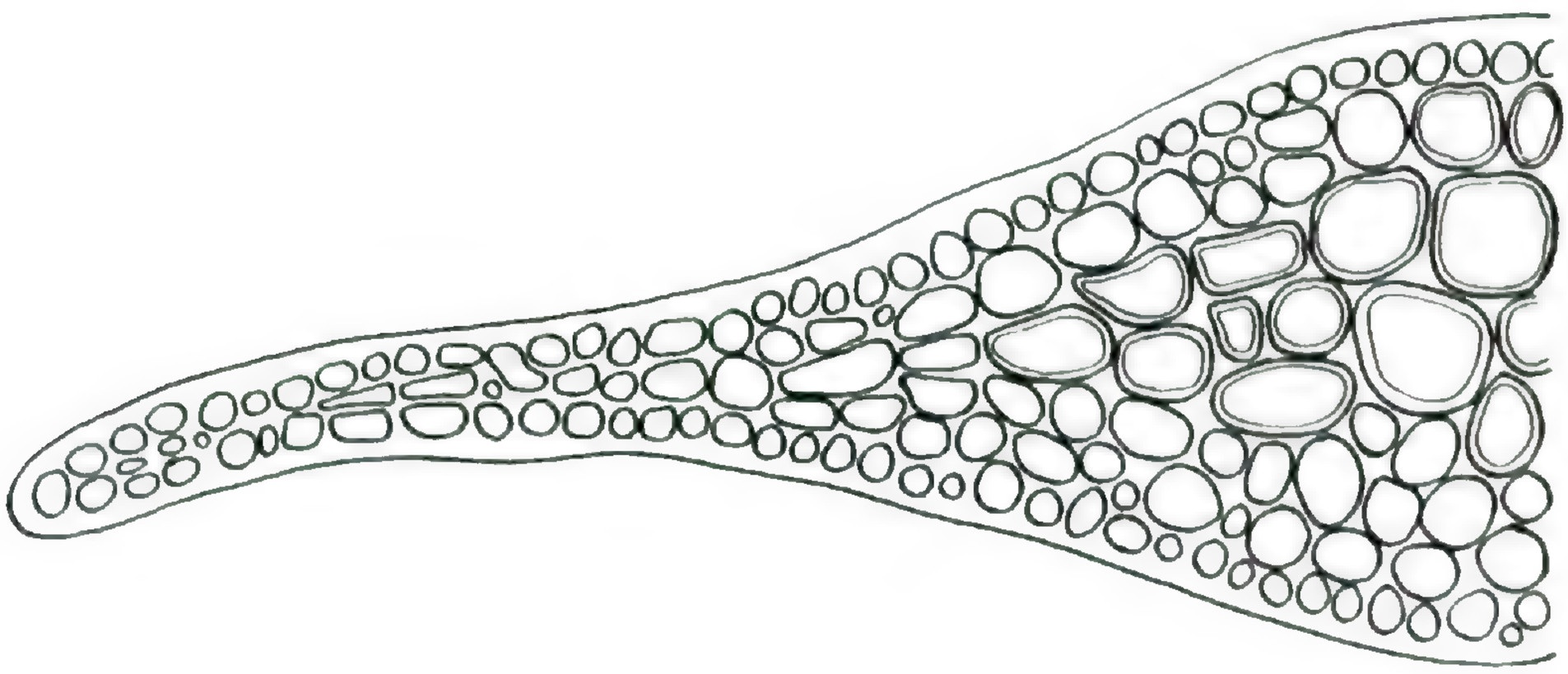

Fig. 6. *Pantoneura angustissima.* Transverse section of one of the flattened and alate main branches in upper half of plant. (Specimen in Farlow Herbarium from Scotland, exact locality and collector's name not given, det. & commun. J. Agardh, *s. n.* "*Delesseria angustissima.*")

The results of the above observations can be incorporated in the following key to the three species discussed above:

1a. Marginal membranous fringe always present and obvious, entirely monostromatic (uncorticated) ..... *Membranoptera alata*

1b. Marginal membranous fringe little developed or absent; when present, mainly tristromatic (or apparently distromatic in section), *i.e.* corticated.

2a. Large axial midrib-cells in upper branches distinct in surface view. ..... *Pantoneura baerii*

2b. All cells of upper branches uniform in surface view, small, rounded and more or less isodiametric .... *Pantoneura angustissima*

With regard to *Membranoptera alata*, it may be noted that most of the material which occurs on New England coasts is a very narrow form of the species with the main branches, including the lateral membrane, only 0.5 to 1.0 mm in width. Harvey (1853, p. 95) drew attention to this narrow form from the Boston area. Such plants have frequently been misidentified as "*Delesseria angustissima*" and they do greatly resemble a *Pantoneura* species except for the presence of the monostromatic fringing membrane along the main axis and branches. When, as sometimes happens, this fringing membrane is poorly developed or worn away, it is sometimes rather difficult to distinguish such narrow forms of *Membranoptera* from *Pantoneura*.

Concerning Kylin's suggestion that *P. baerii* may be conspecific with *P. corymbosa* and *P. rostrata* (Kylin, 1924, p. 18), we have no useful evidence to offer, and it is obvious that the question can be satisfactorily settled only by an examination of the type specimens and an intimate acquaintance with the morphological variability of the species in nature. Already Ruprecht (1851, p. 242) suggested that his new species *Delesseria baerii* might be identical with Lyngbye's *Gigartina purpurascens* γ. *rostrata*. Kjellman (1883, p. 133) regarded *Delesseria baerii* and *D. corymbosa* as separate species. However, his illustration of the latter (*op. cit.* Pl. 10, fig. 3) resembles exactly the habitus of our Cape Ann specimens and the illustration of *P. baerii* in Taylor (1937, 1962, Pl. 44, fig. 6). Rosenvinge (1893, p. 808) regarded *D. baerii* and *D. corymbosa* as conspecific, but attempted to distinguish the latter as a variety of the former. In these species the branching is characteristically dichotomous, whereas in *P. rostrata* it is said to be alternately pinnate (Rosenvinge, *op. cit.* p. 804). According to De-Toni (1897, p. 711-712) *P. rostrata* is distinguished from *P. baerii* by having more elongated and regular midrib-cells;

however, the population studied by us on Cape Ann shows considerable variation in this respect.

We have not seen the original type-materials of *P. baerii* collected by v. Baer in 1837 on the coasts of Russian Lapland at Triowstrowa and Pjalitza (Ruprecht, 1851, p. 239), and do not know where they may be located. However, one of us (Lamb) found in the Agardh Herbarium at Lund in 1964 two authentic specimens distributed from Herb. Acad. Petropol., labelled as follows: "Rhodomenia Bærii P.R. Litt. Oceani glacial. Promont. Kanin. Dr. Ruprecht", and "Delesseria Bærii R. Mare Ochotzk — leg. Wosnessensky." Both these specimens exactly resemble the North American material in gross morphology and habitus.

Delesseria baerii was first recorded from North America by W. G. Farlow (1886, pp. 471-473) on the basis of specimens collected in Labrador, Ungava Bay, by L. M. Turner in 1884. Some of this material was subsequently distributed in the exsiccat Farlow, Anderson and Eaton, Algæ Exs. Amer. Bor., fasc. V, no. 188 (1889). In the same paper Farlow also recorded its occurrence in Prince Edward Island, comm. Mrs. A. L. Davis. Rosenvinge (1893, p. 808) gives the general distribution of the species (including var. *corymbosa)* as Russian Lapland (White Sea), Spitzbergen, Murmansk Sea, Ochotsk Sea, Bering Sea, Iceland and Labrador. Kjellman (1883, p. 133) had already mentioned its occurrence also in Novaya Zemlya and (as *Delesseria corymbosa*) on Baffin Island and the west coast of Greenland. De-Toni (1897, p. 711) lists it further from Jan Mayen. Lund's (1933, p. 9, 17) later record of it from Craig Harbor, Ellesmere Island, serves further to emphasize its distinctively arctic-circumpolar distribution, and appears to be the northernmost record for North America. In the summer of 1963 Dr. R. T. Wilce collected *P. baerii* on the coast of Devon Island in the Canadian Arctic archipelago. On the assumption that *Delesseria rostrata* is synonymous with *Pantoneura baerii*, we may add also to this list the locality in Cumberland Sound, Baffin Island, where plants were collected by L. Kumlien in October 1877 (Howgate Polar Expedition, 1877-

78, nos. 270, 271, 274, enumerated as "*Delesseria rostrata*" by Farlow in his published list of 1879).* Dr. Constance MacFarlane *(in litt.*, 1963) has informed us that *Pantoneura baerii* was found on two occasions washed ashore near Halifax, Nova Scotia, after severe fall and winter storms, and was seen also at Digby Neck in the Bay of Fundy. These new records, together with the above-mentioned previous record from Prince Edward Island (material seen by us in Farlow Herbarium) and our own collection of *P. baerii* from Cape Ann, Massachusetts, therefore represent a notable southerly extension of the general arctic-circumpolar areal of the species (Fig. 7). Our collections from Cape Ann were not the first of the species from that locality, for in the herbarium of F. S. Collins (New York Botanic Garden) there is a typical specimen of *P. baerii* from Massachusetts, Cape Ann, coll. Putnam, no date given, named "*Delesseria angustissima*". Most probably the Massachusetts records represent the southernmost limit of the range of the species, although there is a possibility that it may occur as a winter annual in deep water even further south.

It is more difficult to arrive at valid conclusions with regard to the distribution of *Pantoneura angustissima*, the second species enumerated in Taylor's manual (1937, 1962). That species was first recorded from New England coasts, on the authority of Dr. Farlow, in Robinson's *Flora of Essex County* (1880, p. 159), as *Delesseria angustissima*, from Gloucester, Massachusetts, and two years later by Farlow himself, as *Delesseria alata* var. *angustissima*, "from Boston northward" (Farlow, 1882, p. 163). Some years later, Farlow (1886, p. 471) himself cast doubts on the validity of this record: "A single specimen, collected several years ago at Cape Ann, by Mrs. Lusk, and referred by me to *Del.*

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*Farlow had sent a duplicate of one of these specimens — no. 274 — to J. G. Agardh, who replied concerning it — *in litt.*, Lund, June 9, 1879, preserved in the Farlow correspondence files — as follows: "The '*Delesseria rostrata*' is hardly the true one, which is a much more delicate plant. Yours is more convenient with, and indeed hardly different from *Delesseria Baerii*, which may be the same as *Delesseria corymbosa*, also from Greenland."

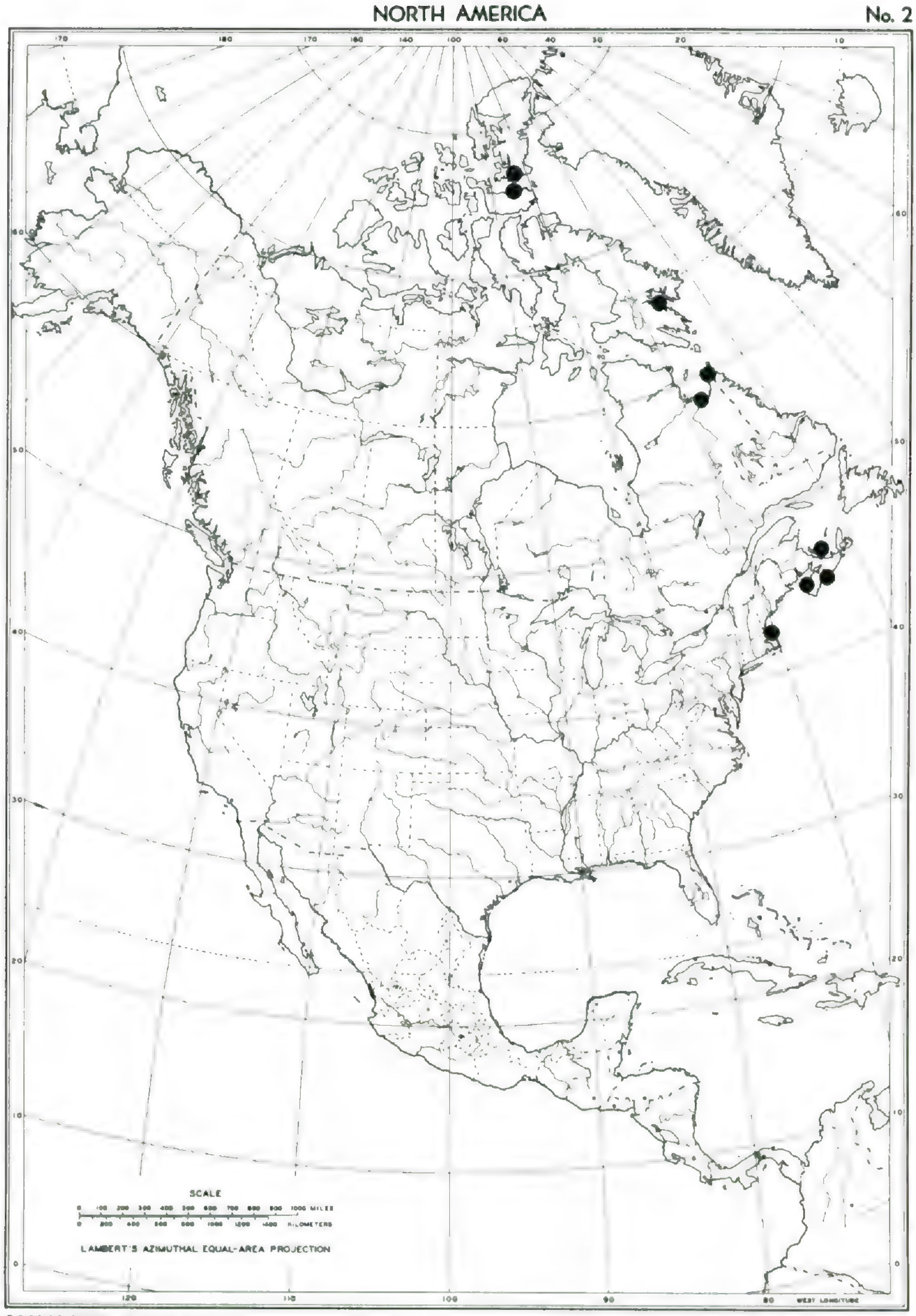

Fig. 7. The known distribution of *Pantoneura baerii* in North America.

angustissima, has cystocarpic fruit. Unfortunately the specimen was somewhat water-worn when collected, and, on that account, the determination is somewhat uncertain." He then goes on to say of *D. angustissima* that it "must be very rare on the American coast, if it occurs at all." What appears to be the Cape Ann specimen referred to is preserved in the Farlow Herbarium, ex Herb. W.G. Farlow, with the annotation in Farlow's handwriting "Delesseria angustissima Cape Ann", no other data. It is cystocarpic, and while its poor state of preservation rules out a completely certain determination, the general outline of the fronds resembles that of *Membranoptera alata,* of which, in the opinion of the present authors, it probably represents a decomposed condition. Another specimen (tetrasporic) in the Farlow Herbarium from Gloucester, Mass., collected by Mrs. Lusk, without further data, is very similar in appearance but better preserved and is undoubtedly *M. alata,* as which species it was originally determined.

Collins (1900, p. 50) listed *Delesseria angustissima* from "Northern Massachusetts." Three years later (1903, p. 207) he wrote: "At Gloucester occurs, though apparently quite rare, *D. angustissima* Griff., which must be carefully distinguished from the narrowest forms of *D. alata.*" These remarks probably refer to the specimen in his herbarium, now in the New York Botanic Garden, from Cape Ann, coll. Putnam, which we have mentioned above and shown to be *Pantoneura baerii.* There is also in the Farlow Herbarium a specimen collected by Collins at Swampscott Massachusetts, in 1878, and determined by him as "Delesseria alata var, angustissima"; it is *Membranoptera alata,* in the narrow form by which the species is usually represented in New England waters.

Most records of *Pantoneura angustissima* on Canadian coasts further north, or indeed for that matter in the circumpolar-arctic zone generally, are equally doubtful; Kjellman (1883, p. 134) stated that he had never seen the species from the Arctic Sea, and cited it as occurring on the subarctic Atlantic coast (Nordland, Norway) only on the authority of

Kleen (1874). who, however, never really stated that it did occur there.* The somewhat doubtful record of *P. angustissima* from the lower St. Lawrence River in Taylor, 1937, p. 346, was omitted in the second edition (Taylor, 1962), and Dr. Taylor informs us *(in litt.* June 26, 1963) that it "may rest on a specimen from the Matamek district, collected byPaul Bowman in the 20's, which I later found erroneous." In the second edition of his manual Taylor added Baffin Island to the geographical distribution of *P. angustissima,* and again he has informed us *(in litt.* November 9, 1963) that this rests on a specimen seen by him from Baffin Island, Frobisher Bay, shore of Koojesse Inlet, lat. 63° 45′ N., long. 68° 34′ W., coll. J. A. Calder and H. A. Senn, July 10-20, 1948, det. W.R.T. Dr. Taylor has kindly furnished us with photomicrographs, taken with the same apparatus and at the same magnification, of branch tips from this specimen and from the type material of *P. angustissima* from the British Isles (coll. Brodie, in Herb. Kew), and they appear very similar, showing a uniform cover of isodiametric cells without any trace of elongated midrib-cells. This specimen from Frobisher Bay therefore seems to be the only well-authenticated record of *P. angustissima* on the coasts of North America.

Kjellman (1883) and Rosenvinge (1893) have given some observations on the ecology and seasonal development of *Pantoneura baerii* as it occurs in arctic waters. The former *(op. cit.* p. 133) states: "*D. Baerii* is in the Arctic Sea a sublittoral alga occurring within the formation of *Laminariaceae* and apparently preferring exposed coasts to the interior of deep bays and other sheltered places. It is usually attached to other algæ, especially to the rhizines of the *Laminanaceae.* On the north coast of Spitzbergen I have found it in full development in the middle of February. Specimens with sporocarps were met with on the West coast of Novaya

*"When it [*Delesseria alata*] occurs in dark and at times bare places it seems to take on the form of var. *angustissima* (*D. angustissima* GRIFF. HARV. Phyc. Britt. Vol. Pl. LXXXIII); this form is found commonly on stones under rock-weed" (our translation from the Swedish original, Kleen, *op. cit.* p. 14).

Zemlya in June and July, at Spitzbergen in August; specimens with tetrasporangia at both these places in the month of July." Rosenvinge's statement (*op. cit.* p. 808) regarding the species in Greenland indicates that there also it is a plant of the sublittoral zone, growing mainly on other algæ such as *Laminaria* and *Ptilota*, and found from late spring to autumn, spermatangial plants having been observed in May and cystocarpic plants in August. These observations are similar to those made by us on the species at Cape Ann, Massachusetts. There we find the species to be restricted to a zone just below the *Laminaria*-belt, at a depth of 12-18 m below mean low tide level, growing on *Phyllophora*, *Chondrus*, *Corallina* and *Ptilota*, more rarely on stipes of *Laminaria*. Reproductive development appears to occur earlier in the season than in the arctic plants mentioned by Kjellman and Rosenvinge, for we have found plants with spermatangia* in January, with cystocarps from January to April, and with tetrasporangia from December to June; from midsummer to autumn the plants, although showing good vegetative development, seem to be constantly sterile.

The authors gratefully acknowledge assistance from various sources in the preparation of the foregoing report. Dr. William Randolph Taylor in particular we would like to thank for much helpful advice and for an excellent series of photomicrographs of type and authentic materials of *Pantoneura* species. Dr. Robert Wilce kindly allowed us to examine material of *P. baerii* collected by him in the Arctic, and Dr. Constance MacFarlane contributed some useful information on the occurrence of that species in Nova Scotia. To Dr. Francis Drouet and Mr. Walter Adey we are indebted for determinations of some blue-green and encrusting calcareous red algæ respectively. We wish to thank the Director of the New York Botanic Garden for the loan of some of the material from the Frank Collins collection for study. Dr. Richard Webster, the owner of Pitcairn Park, not only

*The spermatangia are borne on the surface of spathulately flattened, pale to colorless branch-tips (fig. 5b) and so resemble closely those of *Membranoptera*.

allowed us to conduct our investigations on and from his property, but also followed their development with keen and continued interest. Finally, the authors would like to express their thanks to their technical assistants and fellow divers, Messrs. R. A. Fralick, R. E. Waterhouse and R. Knowles, who rendered valuable services at all seasons over the whole period covered by this investigation.

SUMMARY

The seasonal development of the littoral and sublittoral marine algæ of Pitcairn Park, Halibut Point, Cape Ann, Essex County, Massachusetts, was studied by making observations at approximately bimonthly intervals over a period of three years. Three seasonal groups can be distinguished: perennials (in good vegetative development all the year round), pseudo-perennials (overwintering by short stumps or bases from which new growth is put out in the spring), and spring and summer anuals (completely absent in the winter).

The red algal genus *Pantoneura* Kylin (Ceramiales, Delesseriaceæ) has six species attributed to it, of which two, *P. baerii* and *P. angustissima,* have been reported from the coasts of North America. *P. baerii* has an arctic-circumpolar distribution pattern with a southwards extension to Cape Ann, Massachusetts (lat. 42° 39′ N.). With one exception, all North American records of *P. angustissima* are erroneous, being based on misidentifications; a single specimen from Baffin Island, Frobisher Bay does however appear to belong to this species. Distinction between *P. baerii* and *P. angustissima* is facilitated by a key based on the microscopic anatomy of the upper branches. The ecological relationships of *P. baerii* at Cape Ann are described on the basis of underwater field observations.

FARLOW HERBARIUM, HARVARD UNIVERSITY, CAMBRIDGE, MASSACHUSETTS and MARIA MOORS CABOT FOUNDATION FOR BOTANICAL RESEARCH, HARVARD UNIVERSITY

LITERATURE CITED

AGARDH, J. G. 1841. In Historiam Algarum Symbolae. *Linnaea*, **15**:1-50, 443-457.

———. 1852. Species Genera et Ordines Algarum. Vol. II, Part II/2. Lund.

COLLINS, F. S. 1900. Preliminary lists of New England Plants. — V. Marine algae. Rhodora, **2**:41-52.

———. 1903. Notes on Algae. — V. Rhodora, **5**:204-212.

COTTON, A. D. 1912. Clare Island Survey. Marine Algae. Proc. Roy. Irish Acad. **31**, Part 15.

DAVIS, B. M. 1913. A Biological Survey of the Waters of Woods Hole and Vicinity. Part I, Section II, Botanical. Part II, Section IV, A Catalogue of the Marine Flora. Bull. Bureau of Fisheries, **31** (1) :443-544, (2) :795-833, 1911 (1913).

DE-TONI, J. B. 1897. Sylloge Algarum omnium hucusque cognitarum. Vol. IV, Sect. I. Patavii.

FARLOW, W. G. 1879. Algæ. List of algæ collected at points in Cumberland Sound during the autumn of 1877, in: L. Kumlien, Contributions to the Natural History of Arctic America made in connection with the Howgate Polar Expedition, 1877-78. Bull. U. S. Nat. Museum, no. **15**:169.

———. 1882. The Marine Algæ of New England. Rept. U. S. Comm. Fish and Fisheries for 1879. (A facsimile reprint edition was issued in 1891).

———. 1886. Notes on Arctic algae; based principally on collections made at Ungava Bay by Mr. L. M. Turner. Proc. Amer. Acad. Arts & Sci. **21**:469-477.

HARVEY, W. H. 1846-51. Phycologia Britannica: or, A History of British Sea-Weeds. Vol. II, Part I. London.

———. 1853. Nereis Boreali-Americana. Part II. — Rhodospermeae. New York.

HOWE, M. A. 1914. Some Midwinter Algae of Long Island Sound. Torreya, 14 (6) :97-101.

KJELLMAN, F. R. 1883. The Algae of the Arctic Sea. Kgl. Svensk. Vet.-Akad. Handl. **20**: no. 5; 1-350.

KLEEN, E. A. G. 1874. Om Nordlandens högre Hafsalger. Akademisk Afhandling. Stockholm.

KNIGHT, M. AND PARKE, M. W. 1931. Manx Algae. An Algal Survey of the South End of the Isle of Man. LM.B.C. Memoirs, **30**.

KORNMANN, P. 1961. Zur Kenntnis der *Porphyra*-Arten von Helgoland. Helgolander Wiss. Meeresunters. 8 (1) :176-192.

KÜTZING, F. T. 1866. Tabulae Phycologicae oder Abbildungen der Tange. Vol. XVI. Nordhausen.

KYLIN, H. 1924. Studien über die Delesseriaceen. Lunds Univ. Årsskrift, n. F. Avd. 2, **20**, no. 6:1-111.

———————. 1944. Die Rhodophyceen der Schwedischen Westküste, Lunds Univ. Årsskrift, n. F. Avd. 2, **40** (2).
———————. 1956. Die Gattungen der Rhodophyceen. Lund.
KYLIN, H. AND SKOTTSBERG, C. 1919. Zur Kenntnis der subantarktischen und antarktischen Meeresalgen. II. Rhodophyceen. Wiss. Ergebn. Schwed. Südpolar-Exped. 1901-1903, **4**, Lief. 15:1-88.
LEVRING, T. 1940. Studien über die Algenvegetation von Blekinge, Südschweden. Dissertation. Lund.
LUND, S. 1933. The Godthaab Expedition 1928. The Marine Algae. Medd. om Grønland, **82**, no. 4.
LYNGBYE, H. C. 1819. Tentamen Hydrophytologiae Danicae. Hafniae.
MACFARLANE, C. AND BELL, H. P. 1933. Observations of the seasonal changes in the marine algae in the vicinity of Halifax, with particular reference to winter conditions. Proc. Nova Scotian Inst. Sci. **18** (3):134-176.
NEWTON, L. 1931. A Handbook of the British Seaweeds. London. (A facsimile reprint edition was issued in 1958.)
PARKE, M. 1948. Studies on British Laminariaceae. I. Growth in *Laminaria saccharina* (L.) Lamour. Journ. Marine Biol. Assoc. United Kingdom, **27** (3):651-709.
POSTELS, A. AND RUPRECHT, F. 1840. Illustrationes Algarum. Petropolis.
REES, T. K. 1940. A preliminary account of the life-history of *Porphyra umbilicalis* (L.) Ag. Ann. of Bot. n.s. **4**:669-671.
ROBINSON, J. 1880. The Flora of Essex County, Massachusetts, Salem.
ROSENVINGE, L. K. 1893. Grønlands Havalger. Medd. om Grønland, **3**:763-981.
RUPRECHT, F. 1851. Tange des Ochotskischen Meeres, in: Middendorff, A. T., Reise in den äu*ß*ersten Norden and Osten Sibiriens, **1**, Theil 2, Botanik Erste Abtheilung: 193-435.
SKOTTSBERG, C. 1907. Zur Kenntnis der Subantarktischen und Antarktischen Meeresalgen. I. Phæophyceen. Wiss. Ergebn. Schwed. Südpolar-Exped. 1901-1903. Band IV, Lief. 6.
SVEDELIUS, N. 1901. Studier öfver Östersjöns hafsalgflora. Akademisk Afhandling. Uppsala.
TAYLOR, W. R. 1937. Marine Algae of the Northeastern Coast of North America. Ann Arbor.
———————. 1962. Marine Algae of the Northeastern Coast of North America. Second edition, revised, Ann Arbor.
TURNER, D. 1800. Calendarium Plantarum marinarum. Trans. Linn. Soc. Lond. **5**, 1799 (1800):126-131.
———————. 1811. Fuci; or, Colored Figures and Descriptions of the Plants referred by Botanists to the Genus Fucus. Vol. III. London.

DRYOPTERIS GOLDIANA × INTERMEDIA — A NATURAL WOODFERN CROSS OF NOTEWORTHY MORPHOLOGY

A. Murray Evans and W. H. Wagner, Jr.

During the past ten years our studies of the species and hybrids of the woodferns, *Dryopteris*, of the United States have been gaining momentum. The pioneering field and herbarium researches of R. C. Benedict (1909) and E. T. Wherry (1961) over several decades have recently been supplemented by numerous cytogenetic investigations, especially those of Stanley Walker of the University of Liverpool (1962a, 1962b, and bibliography). Nevertheless, there are still vexing problems. For example, the relationships of the members of the *D. spinulosa* group are still in dispute (cf. Wagner and Hagenah, 1961). The confusing situation involving *D. clintoniana*, *D. wherryi*, and *D. celsa* in the area of New Jersey to North Carolina is still to be untangled (cf. Walker, op. cit.).

As is well known, hybridization is of major significance in creating the variation pattern of North American woodferns. However, a number of the interspecific crosses have yet to be described in sufficient detail to enable workers to recognize them readily. Some of the sterile hybrids found growing naturally are actually frequent to common members of the flora (e.g., *D. cristata* × *intermedia* and *D. intermedia* × *spinulosa*). Others are apparently extremely rare and sporadic, and it is one of the latter group with which we are concerned in this paper. The less common hybrid combinations are so poorly described in some cases that we find many herbarium collections which are misidentified and indeed many are not named in any way.

One of the most unusual of the rare hybrid woodferns is *Dryopteris goldiana* × *intermedia*, a cross which we might expect to occur freely in nature because of the more or less constant association of the parents. For some reason, however, the gametes of the parents must be incompatible to a

large extent. We have examined thousands of plants in dozens of localities without finding this cross. In fact, it was not until Evans discovered a specimen in August, 1963, growing with the parents in Vermont, that we were able to study living material of the cross at all. Charged with Evans' success in discovering material, we made an intensive search together in previously unexamined localities in Michigan, and succeeded in finding an additional plant with the same morphology. It seemed particularly desirable to collect additional material, because the first plant had the appearance of a "lop-sided" hybrid, the structure of the leaf apparently resembling *D. intermedia* much more than *D. goldiana*. Subsequently materials were borrowed from herbaria, and they were found also to conform to this pattern.

In the study of vascular plant hybrids we have come to expect primary crosses to be intermediate between the parents in most or all of their observable morphological details. This is especially true of fern hybrids, because practically all of them are what might be termed "F_1's." Either they are sterile, or they are fertile and have become amphiploids presumably by direct transformation of "F_1's." We were therefore greatly surprised to find that the cross of *D. goldiana* and *D. intermedia* resembled more a backcross to *D. intermedia* than a primary hybrid. Since the species characters of ferns are presumably controlled by a multitude of genetic factors, as a rule, they should, when combined, produce approximately intermediate conditions. Simple dominance or recessiveness should be the exception rather than the ordinary situation.

Accordingly, it is our purpose here to describe in some detail the cross *Dryopteris goldiana* × *intermedia* and to note briefly what we consider to be peculiarities of its morphology. We are indebted to the curators of the Gray Herbarium, the University of Pennsylvania, the Philadelphia Academy, the New England Botanical Club, and the New York Botanical Garden, for providing us their materials for examination. Also, we acknowledge R. C. Benedict and E. T. Wherry for their helpful letters; D. J. Hagenah for

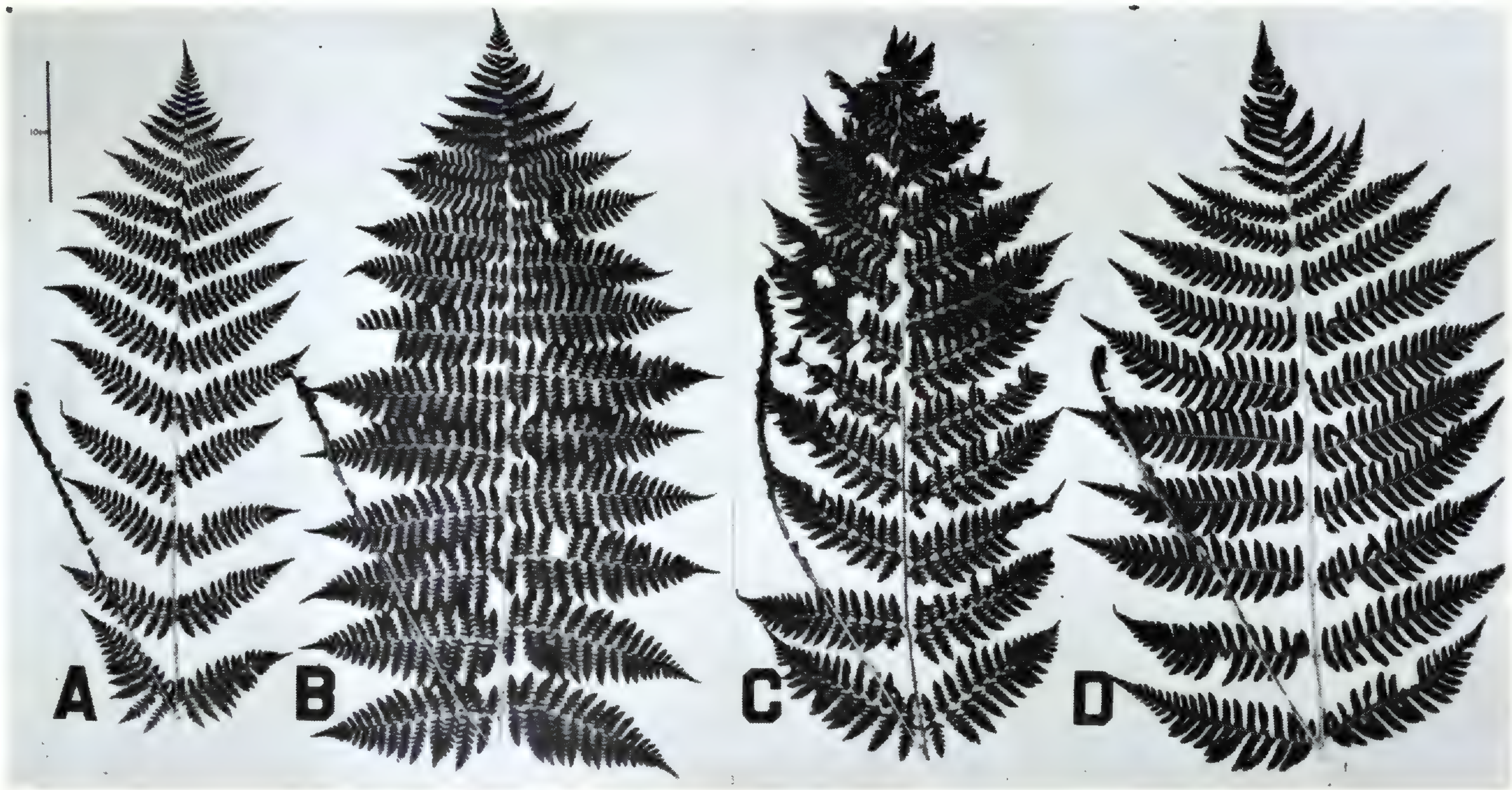

Plate 1302. Whole fronds of *Dryopteris*. A. *D. intermedia,* Mich., Antrim Co., *Evans 2027* (MICH). B. *D. goldiana* × *intermedia,* same locality, *Wagner 63144* (MICH). C. *D. goldiana* × *intermedia,* Vermont, Windsor Co., *Evans 1172* (MICH). D. *D. goldiana,* same locality as "A" and "B," *Evans 2029* (MICH). (Scale = 10 cm.).

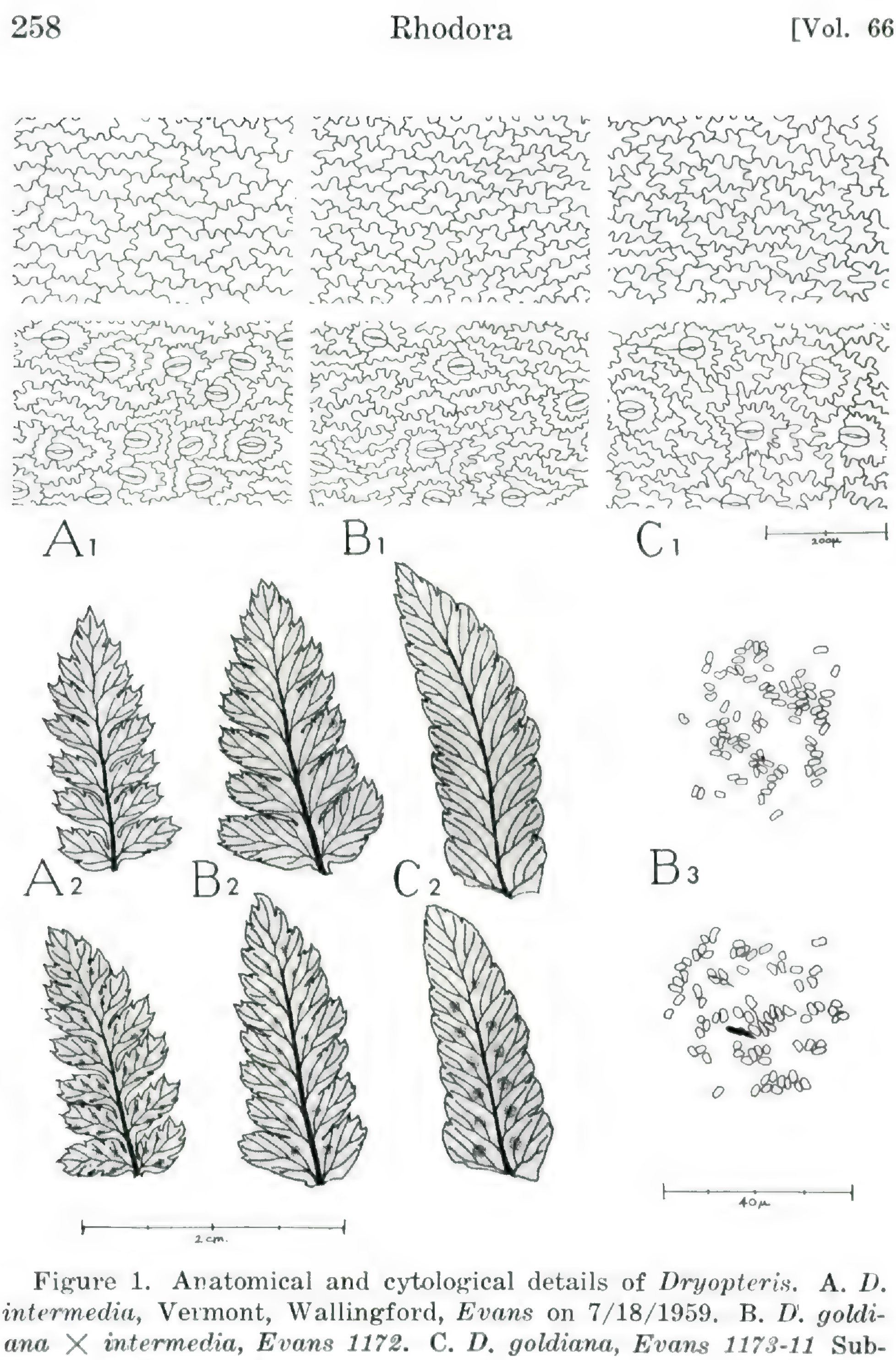

Figure 1. Anatomical and cytological details of *Dryopteris*. A. *D. intermedia*, Vermont, Wallingford, *Evans* on 7/18/1959. B. *D. goldiana* × *intermedia, Evans 1172*. C. *D. goldiana, Evans 1173-11* Subscript 1. Epidermal patterns, upper epidermis above, lower below. Subscript 2. Venation patterns of corresponding segments. Subscript 3. Chromosomes at meiotic metaphase of *D. goldiana* × *intermedia, Evans 1172*, the upper figure showing no pairing, the lower showing a single pair, $2n = 82$.

his guidance in the field research; Katherine Lim Chen for her assistance in the laboratory. The study was carried out under National Science Foundation Grant G-10846.

That collectors have often been in doubt as to what they had found is indicated by the question mark beside the hybrid formula on the New England Botanical Club specimen, and the fact that of the four sheets in the New York Botanical Garden, only one has an identification, a lightly pencilled "D goldiana × intermedia" below the label at the bottom of the herbarium sheet. We wonder ourselves whether we have not overlooked this plant in the field because it resembles a very large individual of *D. intermedia* when examined casually (Plate 1302, B. C). Some of the specimens, especially those of Dutton and of Harlow cited below can be matched in cutting with almost perfect precision by selected specimens of the related *D. spinulosa*. In the very brief original description, Dowell (1908, basing his conclusions on the single Underwood collection) stated accurately that "In general appearance this fern looks like a large overgrown *D. intermedia* . . ."

Six collections from four states are now known of this scarce plant, and all of them conform closely to the same morphology. These collections may be cited as follows:

PENNSYLVANIA: Monroe Co., 5 mi. e. of La Anna, cut-over swamp, *R. C. Harlow* in 1946 (GH); Franklin Co., wooded rocky ravine, 5 mi. n. e. Ft. Loudon, *D. L. Emory* on May 26, 1963 (PENN). VERMONT: Rutland Co., Brandon, *D. L. Dutton* in 1923 (NEBC); Windsor Co., Barnard Gulf, steep, rocky, wooded slope, *A. M. Evans 1172* (MICH). NEW YORK: Chautauqua Co., Jamesville, *L. M. Underwood* in 1899 (4 sheets — NY). MICHIGAN: Antrim Co., T30N, R6W, Sect. 17, ca. 6 mi. n. of Mancelona, steep, springy hillside woods, *W. H. Wagner 63144* (MICH). A few collections which are patently *not* this hybrid are discussed below.

In Table 1 we have summarized some of the salient characters of the hybrid and the illustration (Plates 1302, 1303, and Figure 1) contain the most important information. It is therefore unnecessary to expand on these characters here, except to comment on the noteworthy, seemingly "unexpected," features. One of the details of the hybrid, namely its glandularity, does actually seem to show "dominance," al-

TABLE I

	D. goldiana	*D. gold.* × *int.*	*D. intermedia*
1. Habitat	Loamy, springy shaded slopes and swamp margins. Very local.	Loamy, springy shaded slopes and swamp margins. Sporadic.	Ubiquitous in various types of marshes, swamps, upland woods. Common to abundant.
2. Color of largest petiole scales	Shiny blackish chestnut except for narrow pale margins.	Shiny blackish chestnut in central area, but with broad pale margin.	Pale, except for more or less dark brownish area near attachment.
3. Pinna cutting	Lobed except at base.	1-pinnate except at base, the pinnules lobed.	2-pinnate.
4. Blade ratio, length/width	1.9 (1.7-2.2)	2.0 (1.8-2.2)	2.4 (2.3-2.6)
5. Petiolule length, center of rachis to costule departure	6.9 (5.5-8.0) mm.	5.0 (3.0-7.0) mm.	3.2 (2.0-4.0) mm.
6. Lamina (freshly dried)	Pale, dull green chartaceous.	Bright green chartaceous.	Bright shiny green, somewhat leathery.
7. Sori	In 1 row along each side of lobe.	1-several rows along each side of pinnule.	Several rows along each side of pinnule.
8. Indusia	Eglandular	Densely glandular	Densely glandular
9. Spores	Normal	Abortive	Normal
10. Chromosomes (Metaphase I)	41 pairs	82 singles (rarely 1 pair)	41 pairs

though from past experience we have come to expect this in all crosses involving *D. intermedia*. It is not necessarily a perfect picture (cf. Wagner and Hagenah, op. cit.), but in general the fact that the glandularity of *D. intermedia* is transferred completely to all of its hybrids makes this an

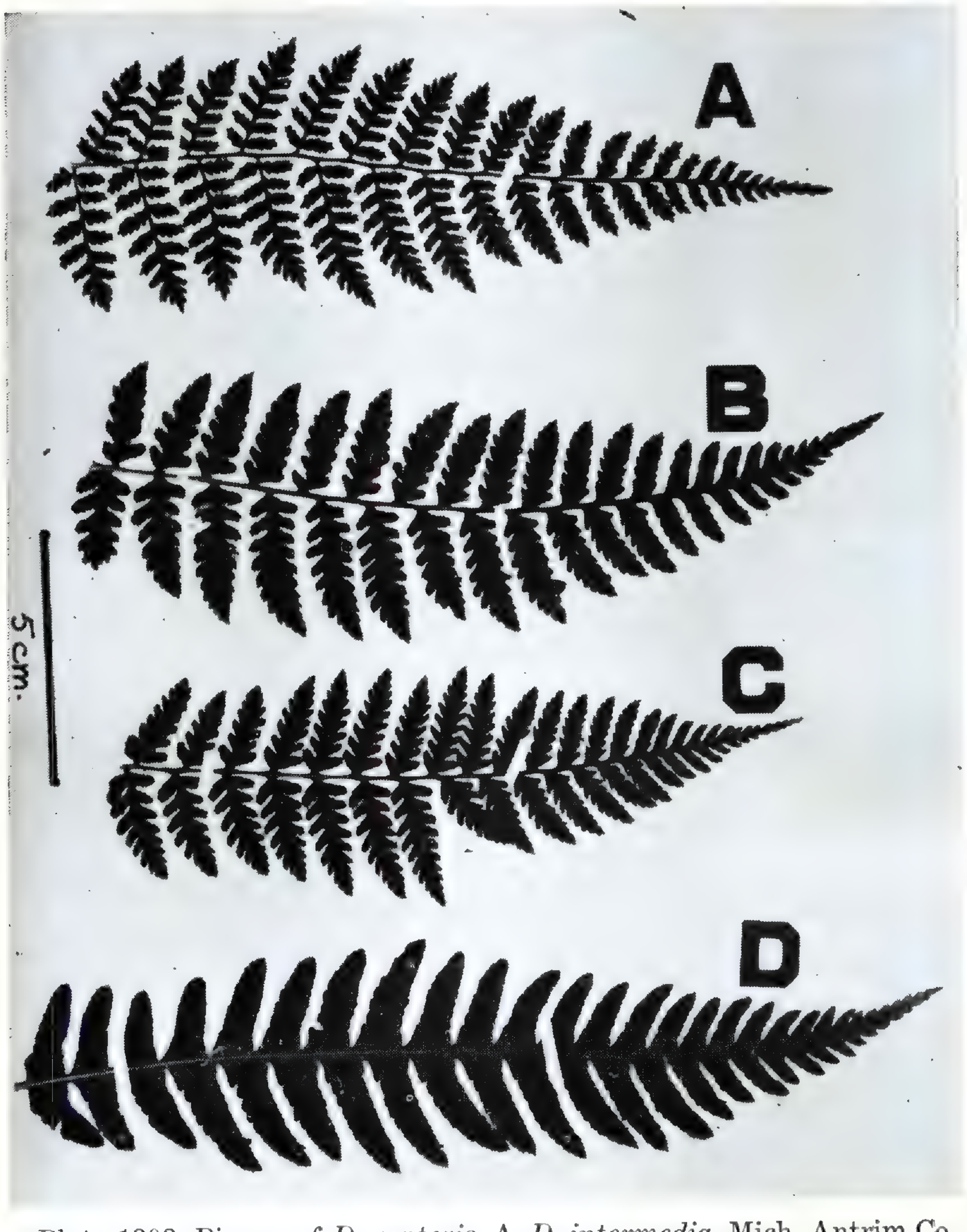

Plate 1303. Pinnae of *Dryopteris*. A. *D. intermedia*, Mich. Antrim Co., *Evans 2031* (MICH). B. *D. goldiana* × *intermedia*, same locality, *Wagner 63144* (MICH). C. *D. goldiana* × *intermedia*, Vermont, Windsor Co., *Evans 1172* (MICH). D. *D. goldiana*, same locality as "A" and "B," *Evans 2030* (MICH).

extremely valuable field character, as students of these plants are well aware. We cannot find that the indusia of *D. goldiana* × *intermedia* are any less glandular than those of *D.*

intermedia. *D. goldiana* has entirely glabrous indusia. We conclude that in those hybrids we have examined, indusial glandularity is entirely dominant and the condition is not intermediate, the hybrid glands only scattered and sparse as we might postulate from the glabrousness of *D. goldiana*.

At present we have seen cytological figures only of the Vermont plant. There is nothing at all unexpected about the chromosome pairing behavior of the hybrid. Although in the related genus *Polystichum*, interspecific hybrids commonly show a considerable degree of pairing, in the genus *Dryopteris* unrelated genomes tend to lack pairing entirely or to show only casual pairs, as shown, in the present case, in Figure 1, [B_3]. This pairing condition is now well known in such other diploid hybrids as *D. dilatata* (Lake Superior "taxon") × *intermedia*, *D. dilatata* (L. Superior) × *marginalis*, and *D. intermedia* × *marginalis*.

The unexpected morphological feature of the hybrid involves the remarkably unbalanced appearance of the cutting of the leaf. Because the pinnæ are themselves entirely divided (cf Plate 1303) instead of merely pinnatifid as in *D. goldiana*, the superficial appearance of the blade is greatly modified. Each segment with its own stalk tends to have an at least slightly twisted orientation (lost in drying in a press) and the surface and detailed outline of the blade thus appears "roughened." The result is that the frond presents a more lacy appearance than we would expect. The coarse, dull-green appearance of *D. goldiana* pinnæ seems vastly different from the more lacy, "spinulose" and shiny green appearance of *D. goldiana* × *intermedia*. Our analysis of this situation will be discussed below.

The following specimens exemplify collections which do not conform to our concept of *D. goldiana* × *intermedia*. They wiill be listed according to the names placed on the labels, and the reasons for our interpretations presented:

1. "Dryopteris celsa, D. goldiana × spinulosa?, D. goldiana × intermedia." MARYLAND: Harford Co., rocky woods on Mason's property, *E. T. Wherry* on 8/24/41 (PENN, PH). The two specimens do not agree with *D. goldiana* × *intermedia* in the following details: (a) the secondary segments are more broadly adnate and not so deeply incised;

(b) the texture is firmer, more leathery; and (c) the basal pinnae are more triangular. Comparison with our own materials of "*D. wherryi*" × *intermedia* from Harford Co., Maryland, plus the various illustrations of *D.* × *separabilis (D. celsa* × *intermedia)* including those of Walker (1959) indicates that the specimens cited are closer to these than *D. goldiana* × *intermedia.* (It should be mentioned here that there is a real possibility that "*D. wherryi*" = *D. celsa,* and that "*D. wherryi* × *intermedia*" = *D.* × *separabilis.* Current investigations are under way to analyze this situation.)

2. "D. goldiana × intermedia." VERMONT: Bennington Co., Dorset, *E. H. Terry* on 11/6/1915 (NEBC). This specimen is almost surely some other woodfern hybrid combination. It is sterile (as judged from the sporangial contents), and the blade only is represented (the petiole is missing). Nevertheless, three characters do stand out: (a) the complete absence of glandularity; (b) the full or almost full adnation of the basis of the secondary segments; and (c) the triangular basal pinnae. The specimen is probably *D. clintoniana* × *spinulosa.* (It is conceivable that it could represent *D. goldiana* × *spinulosa,* which is another cross that has apparently never been clearly described, and with which we are as yet unfamiliar.)

3. "D. goldiana × intermedia?" VERMONT: probably Rutland Co., Ex herb. *G. A. Woolson* (NY). According to the annotation, the specimen, which comprises only the upper part of the blade, has "some indusia glandular, but glands few, minute." Our search under the high-powered dissecting microscope, supplemented by indusial dissections treated in lactic acid, failed to expose any glands. We wonder, therefore, whether the earlier annotator did not see some whitish spores which have accumulated in the folds of the dried and curled indusia of this specimen. In any event, the cutting of the pinnae seems to be exactly that of *D. goldiana.* There is nothing about the blade structure that suggests influence of *D. intermedia.* Moreover, the spores of the fully developed sporangia are normal, as in *D. goldiana.*

The specimens of "*D. goldiana* × *intermedia*" noted directly above differ from that hybrid, as we know it, and must be re-interpreted. Those specimens which we have cited earlier as representing true *D. goldiana* × *intermedia* make a quite uniform and distinctive series, all showing the noteworthy morphological feature to be discussed below.

We have endeavored to analyze what it is that makes this hybrid appear to be so unequal an intermediate in gross aspect, being closer in the apparent structure of its fronds to one of its parents than the other. No one familiar with the species and hybrids of woodferns in eastern North America will fail to notice the close superficial similarity of

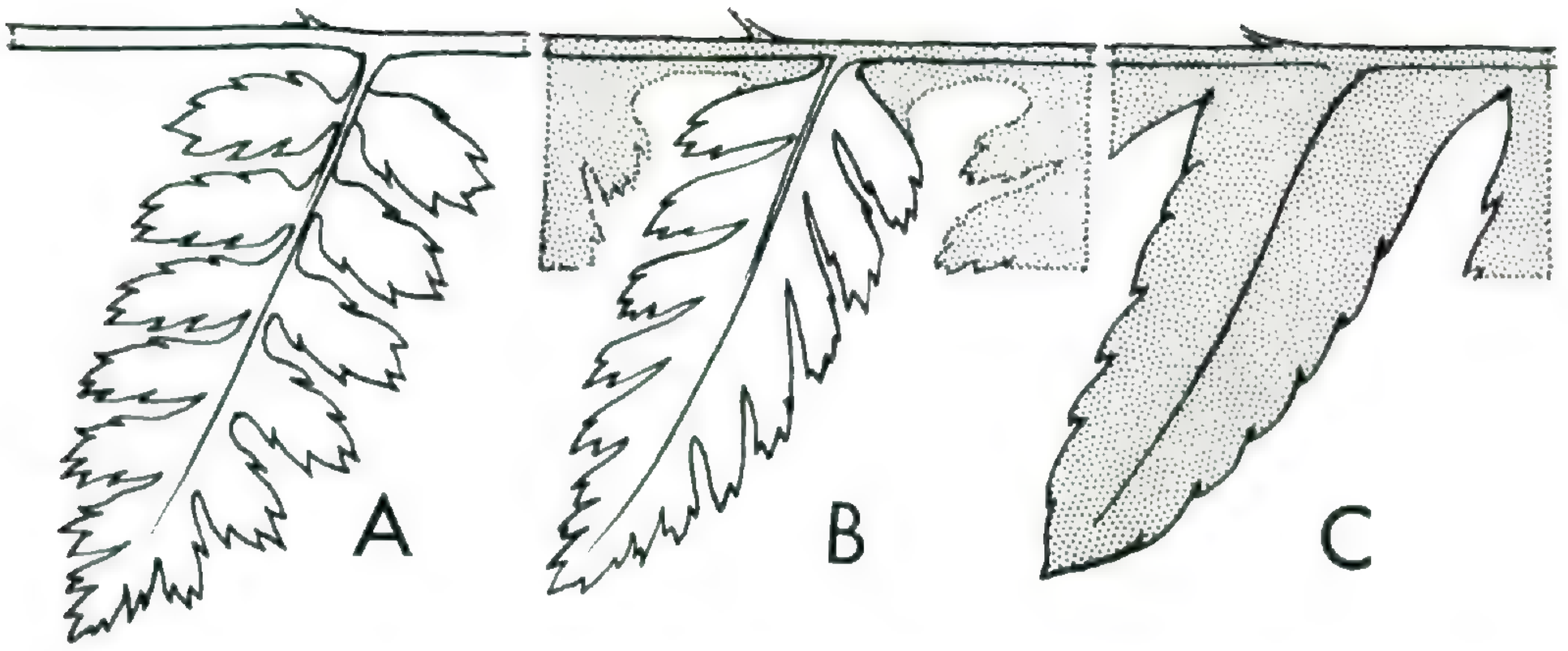

Figure 2. Hypothetical diagram showing corresponding leaf parts of A. *D. intermedia*, B. *D. goldiana* × *intermedia*, and C. *D. goldiana*. The shaded area in "B" suggests what might seem to be a more intermediate "compromise" (i.e., the basal attachment more adnate and the costal wing more developed) between the segment bases of the parents than actually does exist in the cross.

the hybrid frond to *D. intermedia*. It is our conclusion that this seeming proximity to one of the parents can be ascribed to the cutting of the segments alone, for (as shown in the summation of characters in Table 1) the plant is actually a good intermediate in most other respects.

The attachments of the secondary divisions of the frond of the hybrid are not intermediate. In *D. goldiana* the secondary divisions are mere lobes, attached so broadly that they are actually confluent with the adjacent segments, as shown in Plate 1303 and Figure 2, C. There is a laminar wing, therefore, that runs along most of the pinnæ on either side of the costa. In *D. intermedia*, on the contrary, the secondary divisions are truly pinnules (themselves deeply pinnate), and the secondary divisions are of course attached by obvious, fully contracted stalks. There is no well developed laminar wing along the costa. One looking merely at the attachments of the secondary segments would expect in an intermediate hybrid that they would show a broad attachment, as shown in the hypothetical diagram (Fig. 2, B, the shaded area), but such is not the case. The fact is that the attachment of the pinnules is almost exactly as it is in *D. intermedia*.

This situation is a very good illustration of the possible dangers of quantifying taxonomic characters without reference to morphological knowledge. If we concentrated alone on the attachments of the secondary segments as a basis of comparison, we would conclude, as shown above, that *D. goldiana* is "fully adnate." Therefore, quantitatively, we might say that "adnation = 1." *D. intermedia* is not adnate at all; therefore its "adnation =0." The hybrid, if intermediate, should have the condition, "adnation = 0.5." But it does not: quantitatively it shows the same as *D. intermedia* — "adnation = 0."

But now, if we look over the whole frond structure, we find a different picture. The situation, in terms of frond division or leaflet formation, is in fact nicely intermediate. *D. goldiana* is 1-pinnate; *D. intermedia* is 3-pinnate; and their hybrid is 2-pinnate. From the standpoint of ontogeny, *D. goldiana* crosiers develop true leaflets (i. e., non-adnate, obviously stalked segments) only at the earliest stage, so that the subsequently formed segments are merely lobes at best. *D. intermedia* crosiers, on the other hand, continue their leaflet formation after the earliest stage. First they form the primary leaflets (the pinnæ), next they form the secondary leaflets (the pinnules), and finally they divide into tertiary leaflets (ultimate or tertiary pinnules). The hybrid is thus intermediate morphogenetically: the earliest stage is the same, the secondary stage is the same, but the tertiary stage is lacking — exactly what would be expected ontogenetically in a perfect intermediate.

What this means in terms of secondary-segment attachments is that they can be interpreted only in relation to the whole of the morphogenetic process that leads to leaflet formation. Thus the process of pinnation in this case transcends the details of the simple description of segment outlines of a given order (as shown in Figure 2). What this means in terms of superficial appearance to the field and herbarium botanist is that the frond of the hybrid seems to match *D. intermedia* much more closely than it does *D. goldiana*. The eye sees a myriad of individual segments,

each with its own stalk and orientation, so that the frond has approximately the same decompound and highly complex aspect with which we are familiar in *D. intermedia*. The leaf of *D. goldiana* appears merely "streamlined" and simple because of its nearly flat, only deeply lobed pinnæ.

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LITERATURE CITED

BENEDICT, R. C. 1909. New hybrids in *Dryopteris*. Bull. Torrey Club **36**: 41-49.

DOWELL, PHILIP. 1908. New ferns described as hybrids in the genus *Dryopteris*. Bull. Torrey Club **35**: 135-140.

SMALL, J. K. 1938. Ferns of the southeastern states. Lancaster, Pa.

WAGNER, W. H. JR. AND DALE J. HAGENAH. 1962. *Dryopteris* in the Huron Mountain Club Area of Michigan. Brittonia **14**: 90-100.

WALKER, STANLEY. 1959. Cytotaxonomic studies of some North American species of *Dryopteris*. Amer. Fern Jour. **49**: 104-112.

———, 1962a. Further studies in the genus *Dryopteris*: The origin of *D. clintoniana*, *D. celsa*, and related taxa. Amer. Jour. Bot. **49**: 497-503.

———, 1962b. The problem of *Dryopteris leedsii*. Amer. Jour. Bot. **49**: 971-974.

WHERRY, E. T. 1961. The fern guide. Doubleday and Co. Garden City, New York.

A NEW SPECIES OF RATIBIDA (COMPOSITAE) FROM MEXICO

EDWARD L. RICHARDS

In the summer of 1962, while on a collection trip[1] in the Sierra Madre Occidental of northwestern Mexico, a new species of *Ratibida* was found. The local inhabitants refer to this plant as "Bavasia" while *R. mexicana* is called "Howinowa" by the Tarahumar Indians of this area. The new *Ratibida* is presently known only from Chihuahua, Mexico, and occurs in pine forest meadows, valleys and hillsides along the Sierra Madre Occidental.

Ratibida latipalearis Richards, sp. nov. Calamus ramosis sulcatis, 5.5-11.7 dm. altitudine decem jugis calamorum subter florescendum. Basalia folia petiolis 3.2-26.5 cm. longis ovato-obovata, cum tribus venis et cum crenatis marginibus pinnis usque ad 3-7. Laterales totis cum segmentis aut serratis aut crenatis et oblongis-oblanceolatis, 0.2-4.0 cm. longitudine, 0.2-2.4 cm. latitudine. Terminalis lobus 2.0-7.0 cm. longitudine, 0.2-3.6 cm. latitudine, cum margine serrato-crenato. Superioria folia ovata-obovata aut oblonga, 2.7-14.3 cm. longitudine, 1.9-8.5 cm. latitudine, aut pinnato-divisis cum 3-9 pinnis; terminali segmento lanceolato et diviso aut scisso, 2.0-7.0 cm. longitudine, 0.6-4.5 cm. latitudine; lateralibus segmentis oblanceolatis et totis aut scissa, 0.2-4.7 cm. longitudine, 0.1-1.5 cm. latitudine. Phyllaria cum aut sine nigris glandibus distinctis in interiore superficie phyllariorum reflexorum. Paleae 2.0-3.0 mm. longitudine, 2.0-5.0 mm. latitudine, adaxiali margine late alato et ciliato, plurimis fulvis usque nigris unicellulosis glandibus in inferiore margine abaxiali. Discoideae corollae luride pullae, interiore reflexorum petalorum loborum superficie cum nigris glandibus distinctis. Antherae cum nigris glandibus distinctis in exteriore superficie. Achenia glabra praeter adaxialem marginem ciliatum aut cum fulvis usque nigris unicellulosis glandibus; pappus absens aut squamosus aut cum 1-2 dentibus.[2]

Holotype: Mexico. Chihuahua: Colonia Garcia, 37¼ miles southwest of Colonia Juarez, pine forest meadow, elevation 2250-2300 m., August 29, 1962, *Richards 3770* (KANU). Isotypes: (F, GH, KANU, MO, NY, UC, US). Plants of this new species, previously collected and identified as *R. columnifera* or *R. mexicana*, are as follows: Mexico:

[1]Thanks are due to The Society of The Sigma Xi and Sigma Xi-RESA for a grant enabling travel in Mexico for study of *Ratibida*.

[2]Thanks are due to Dr. Austin Lashbrook of the University of Kansas Latin department for assistance with the Latin diagnosis.

Chihuahua: September 1934, *Dobie 2* (TEX); Chuhuichupa, August-September 1936, *LeSeueur 988* (F, MO, TEX, UC); 10 miles east of Chuhuichupa, September 28, 1939, *Muller 3547* (LUNDELL, UC); Near Colonia Garcia, August 5, 1899, *Townsend & Barber 230* (F, MO, NY, UC, US); About 47 miles west of Vieja Casas Grandes, August 29, 1952, *Tucker 2573* (ARIZ).

Ratibida latipalearis is apparently closely related to *R. columnifera* of temperate North America and *R. mexicana* of northern Mexico. It is distinguished from both by the palea being mostly broader than long; black unicellular glands on the ligules, disc corolla lobes, anther apices and one edge of the palea; leaves more dissected than *R. mexicana* and the pinnate leaf segments broader than in *R. columnifera*.

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AN UNUSUAL ERIANTHUS ALOPECUROIDES — In the course of collecting in the Arkansas Ozarks, during October 1963, the author encountered an unusual specimen (*Robinson 2316*, KANU) of *Erianthus alopecuroides* (L.) Ell. near Lorine, Randolph County. The inflorescence contained 2-awned, pedicellate spikelets intermingled with normal 1-awned ones. Demaree (*34477*, KANU) collected a specimen near Malvern, Hot Springs, County, in October 1953, which has a few 2-awned spikelets.

Dr. Jason Swallen reports, in a personal communication, that material from Arkansas and Missouri deposited in the United States National Museum does not exhibit this condition. An examination of material in the University of Arkansas Herbarium did not reveal any 2-awned specimens.

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The author thanks Mr. R. Segal for photographing the specimen.

Plate 1304. *Erianthus alopecuroides* (L.) Ell. × 8.

MICROCHROMOSOMES IN APHANOSTEPHUS (COMPOSITAE)

EDWIN B. SMITH AND R. ROY JOHNSON

Previous chromosome counts reported for the genus *Aphanostephus* have shown a gametic number of 3, 4, and 5 with one exception of 4 bivalents plus 1 large univalent in a specimen of *A. ramosus* (DC.) Gray (see Table I). However, recent cytological investigation of a collection of *Aphanostephus skirrhobasis* (DC.) Trel, from Wharton Co., Texas *(E. B. Smith #254)* revealed a dimorphic configuration of 3 bivalents plus 4 microbivalents (Fig. 1) in one flower, while other flowers, even in the same head, had various numbers of microchromosomes. The most frequent

Fig. 1. Meiotic anaphase I in *Aphanthostephus skirrhobasis*, showing 8 microchromosomes. Inked-in tracing from negative, × 3200.

configuration was 3 bivalents plus 2 microbivalents and 2 microunivalents. One of the microunivalents was seen to pair with one of the "normal" bivalents in about 15 per cent of the cells observed.

Nuclear complements comprised of dimorphic chromosomes were first investigated in insects at the turn of the century by Wilson (1905). Wilson called the small chromosomes of these complements microchromosomes and defined them as "especially small" chromosomes, "irrespective of their behavior." In plants, microchromosomes were found

in monocotyledons as early as 1933 (McKelvey and Sax) and have been discussed in liverworts (Berrie, 1963). Although delimitation of the family Agavaceae has been based largely on a dimorphic chromosome set (see Cave, 1964), the phenomenon has not been generally investigated among the angiosperms.

TABLE I. — Chromosome counts reported for the genus *Aphanostephus*.

Species	n	Locality	Reported by
A. skirrhobasis	3	None cited.	Turner & Mabry (1964)
A. ramossissimus	4	S & W Texas; Hidalgo & Nuevo Leon, Mexico	Turner & Johnston (1961)
A. arizonicus	4	Pima Co., Ariz.	Raven *et al* (1960)
A. arizonicus	4	Bernalillo Co., New Mexico.	Jackson (1960a)
A. cf. pachyrrhizus	4	Puebla, Mexico	Powell & Turner (1963)
A. ramosus	4	Michoacan, Mex.	Turner *et al* (1961)
A. ramosus	4+1 univ.	Michoacan, Mex.	Powell & Turner (1963)
A. ridellii	5	None cited.	Turner & Mabry (1964)

The authors cannot equate presently the microchromosomes in *Aphanthostephus skirrhobasis* to any of the other descriptive terms used for special chromosome types, such as accessory (Müntzing, 1953) or supernumerary, defined by White (1954) as chromosomes which are present in addition to the normal karyotype, and which are not, or only partially, homologous with members of the "normal complement." The terms microchromosome and supernumerary are not mutually exclusive, since supernumerary chromosomes of a distinctly smaller size are common (e.g., *Halpopappus gracilis*, Jackson, 1960b; *H. divaricatus*, Smith, 1963).

Since the normal complement of *A. skirrhobasis* is apparently $n = 3$, aneuploidy, in the genus, is indicated. Shinners (1946) notes the occurrence of troublesome intermediates between *A. skirrhobasis* and *A. ramossissimus*, while Turner and Mabry (1964) found chromatographic profiles on these two species "almost identical." It seems probable that *A. ramossissimus*, or a similar ancestor, may have

given rise to *A. skirrhobasis* through descending aneuploidy. The microchromosomes in *A. skirrhobasis* may be evidence for aneuploidy, or hybridization between *A. skirrhobasis* and another species of *Aphanostephus*. Further study will be necessary in order to ascertain the origin and pairing behavior of the microchromosomes in *Aphanostephus*.

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LITERATURE CITED

BERRIE, G. K. 1963. Cytology and phylogeny of liverworts. Evolution **17**:347-357.

CAVE, M. S. 1964. Cytological observations on some genera of the Agavaceae. Madroño **17**:163-170.

JACKSON, R. C. 1960a. *In* Documented chromosome numbers of plants. Madroño **14**:111-112.

———. 1960b. Supernumerary chromosomes in *Haplopappus gracilis*. Evolution **14**:135.

MCKELVEY, S. D. AND K. SAX. 1933. Taxonomic and cytological relationships of *Yucca* and *Agave*. Jour. Arn. Arb. **14**:76-81.

MÜNTZING, A. 1963. Effects of accessory chromosomes in diploid and tetraploid rye. Hereditas **49**:371-425.

POWELL, A. M. AND B. L. TURNER. 1963. Chromosome numbers in the Compositae. VII. Additional species from the southwestern United States and Mexico. Madroño **17**:128-139.

RAVEN, P. H. *et al.* 1960. Chromosome numbers in Compositae I. Astereae. Am. Jour. Bot. **47**:124-132.

SHINNERS, L. H. 1946. Revision of the genus *Aphanostephus* DC. Wrightia **1**:95-121.

SMITH, E. B. 1963. A preliminary cytogenetic and morphological study of *Haplopappus divaricatus* (Nutt.) Gray. Unpubl. Master's Thesis, U. of Kansas.

TURNER, B. L. AND T. J. MABRY. 1964. Partition chromatography as applied to taxonomic problems in the Asteraceae. Taxon **13**:11-14.

——— AND M. C. JOHNSTON. 1961. Chromosome numbers in the Compositae III. Certain Mexican species. Brittonia **13**:64-69.

——— *et al.* 1961. Chromosome numbers in the Compositae IV. North American species, with phyletic interpretations. Am. Jour. Bot. **48**:216-223.

WHITE, M. J. D. 1954. Animal cytology and evolution. Ed. 2. Univ. Press, Cambridge.

WILSON, E. B. 1905. Studies on chromosomes. I. The behavior of the idiochromosomes in Hemiptera. Jour. Exp. Zool. **2**:371-405.

NOTES ON PASPALUM MINUS AND ANDROPOGON PERTUSUS IN THE UNITED STATES[1] — Hitchcock and Chase (1950) reported *Paspalum minus* Fourn. to occur in "eastern Texas; Mexico to West Indies and Paraguay". In 1962 I collected the species near Mobile, Alabama. The identification was verified by Thomas R. Soderstrom, U. S. National Herbarium. According to him,[2] the only previous collections in the National Herbarium from the continental United States are "all from Texas (from near Fannett, Beaumont, and Anahuac)." My collection data are as follows:

ALABAMA. MOBILE COUNTY: In sandy area among longleaf pines, approximately 7.2 miles south of Mobile just west of Alabama Highway 163. Small clump forming a sod. Apparently rare. *D. J. Banks 1647*. August 14, 1962. (ASTC, Auburn University, GA, GH, MO, NY, US).

I collected *Andropogon pertusus* (L.) Willd. *(Bothriochloa pertusa* A. Camus) along the Keys Highway near Marathon, Florida in 1961. It was reported by Hitchcock and Chase (1950) as "A troublesome weed in lawns and pastures, State College Miss.; West Indies; introduced from the Old World." J. R. Swallen,[2] U. S. National Herbarium, identified my specimen and noted that it probably was a new record from Florida. However, a check with Erdman West,[2] University of Florida, revealed that the species had been collected "on a golf course in Miami on March 20, 1953, FLAS *66953*." According to Robert Godfrey,[2] Florida State University, no specimens were in his herbarium (July, 1963). According to Thomas Soderstrom,[2] there are several collections of the species from cultivation in the U. S. National Herbarium. It has been grown in experimental nurseries in Texas and Oklahoma. J. R. Harlan[2] and his associates, of Oklahoma State University, have been con-

[1]Contribution No. 56 from the Stephen F. Austin State College Department of Biology. This publication was made possible with the aid of a faculty research grant.

[2]Personal communication.

ducting cytotaxonomic investigations on this species and its relatives. My collection data are as follows:

FLORIDA. MONROE COUNTY: roadside, approximately 5 miles east of Marathon on U. S. Highway 1. Forming a turf. Vegetative condition collected September 9, 1961. Transplanted to greenhouse at Athens, Georgia and collected in flowering condition from pot on November 20, 1961. *D. J. Banks 1234*. (ASTC, FSU, MO, NY, US).

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LITERATURE CITED

HITCHCOCK, A. S. AND A. CHASE. 1950. Manual of the Grasses of the United States, U. S. Dep. Agr. Misc. Publ. 200, 2nd Ed.

THE CHROMOSOME NUMBER OF NEVIUSIA ALABAMENSIS GRAY

The chromosome number of *Neviusia alabamensis*, reported here for the first time, is $2n = 14$. Counts were made from root tip squashes stained in acetoörcein. Voucher specimens of the plant have been deposited in the Herbarium of the University of Alabama.

It is hoped that chromosome counts can be made on material of this species from the Mississippi embayment for comparison. The authors would greatly appreciate receiving seeds or cuttings of this species from any localities outside the state of Alabama.

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MICHELIELLA VERTICILLATA IN OHIO

I have found *Micheliella verticillata* (Baldw.) Briq. (*Collinsonia verticillata* Baldw.) in four stations within a mile of one another in Nile Township, Scioto County, Ohio, all at an elevation of approximately 700 feet. In one, there are only a few plants which have not flowered during the period of observation; a second is in oak woods on an east-facing slope which has been cleared of woody undergrowth; the other two, near each other, are large discontinuous patches near the foot of forested slopes rising to over 1000 feet in elevation. The soil is rich in humus, but rocky, with many sandstone fragments, and fairly moist.

The finding of this Southern Appalachian species near the western border of the Appalachian Plateau adds another species to the ever-growing list of disjuncts and local endemics in this interesting physiographic and vegetational area. Growing with the *Micheliella* are a number of species of the larger mesophytic ferns, and, of greater interest, large numbers of *Disporum maculatum* (Buckl.) Britt., also a local disjunct; and, within a few hundred feet, many *Magnolia tripetala* trees, which are very local in Ohio.

Descriptions in the current manuals (Fernald, 1950; Gleason, 1952; Gleason and Cronquist, 1963; and Small, 1933) all emphasize the approximate or almost whorled leaves. Of eight Ohio specimens, four have two pairs of leaves approximate; three have the pairs of leaves separated by intervals of 1.5 to 3 cm; one has three pairs of leaves — the second 1.5 cm above the lowest pair, and the third 4 cm above the second — an arrangement not at all suggesting "approximate."

Leaves vary in shape from elliptic-obovate to almost oval, to broadly obovate; apex acute to short-acuminate, or in the widest leaves, almost truncate with short (5 mm) acute tip; base from truncate to broad acute. Petioles generally 2.5-3 cm long (1.5-3.5). The inflorescence is a strict panicle, the lower panicle-branches usually less than 1 mm long, the pedicels appearing to arise in opposite clusters; upper flowers usually only one pair at a node.

The corolla is approximately 2 cm long (smaller in later flowers) with broad, almost rhombic lip deeply and irregularly lacerate, the length of segments up to half the width of uncut portion of lip, which is pale straw-color, all except margins suffused with madder, darker between the veins, and the veins red; smaller corolla lobes (2 upper slightly smaller than lateral) finely fringed, yellowish toward margins and along center vein, other parts reddish; stamens 4, filaments madder-red, upper edge of anthers dark madder; style pale, greenish yellow. (Description based on fresh flowers; colors fade when dried.) The throat of the corolla-tube appears to be hairy, because it is filled by the long hairs on lowest part of filaments. Corolla externally (except parts inrolled in bud) and buds glandular-pubescent. Rachis of inflorescence, pedicels, and calyx densely glandular-pubescent, the pubescence on stem continuing dense to below the leaves, decreasing toward base of stem. Leaves coarsely dentate to crenate, pubescent on veins above and with scattered multicellular pale hairs; pubescent on veins beneath with glandular and non-glandular hairs; margin ciliate with pale multicellular hairs (some arising near, not at, margin). Calyx at anthesis 4-5 mm long, in fruit 12-15 mm long, the lobes long-acuminate. Rhizomes hard and woody, crooked and knotty, with few branches.

After fruiting the rachis of the inflorescence shrivels and becomes inconspicuous; plants then might be overlooked or mistaken for the much more common *Collinsonia canadensis*, which however has brighter green glabrous leaves and large branched panicle and starts to flower two months later.

From the foregoing, it is evident that Ohio plants differ in one or more ways from characters given in the manuals, which raised question as to their identity. In consequence, all specimens of the *Micheliella* segregate of *Collinsonia* were borrowed from the New York Botanical Garden. Of these, the *verticillata* specimens were separable geographically into those of the Southern Appalachians (Blue Ridge, Ridge and Valley or Folded Appalachians, and Cumberland

Plateau provinces) and those of middle Georgia in the vicinity of the Fall-Line. The latter differ from those of the mountains. The mountain specimens and the Ohio plants are similar, but differ in minor details. Of the mountain plants, about two-thirds had the leaves approximate.

Flowering specimens from Nile Township, Scioto County, Ohio (Shawnee State Forest), May 18, 1963, are deposited in the Gray Herbarium, Herbarium of New York Botanical Garden, Ohio State University Herbarium, and herbarium of E. Lucy Braun; fruiting specimens (same locality, nutlets beginning to fall), June 12, 1963 are in the Gray Herbarium and the herbarium of E. Lucy Braun.

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A NEW NAME IN DEYEUXIA — In her paper "Las especies del genero *Deyeuxia* de la Provincia de Tucuman (Argentina)." Anna Maria Türpe published the following combination: *Deyeuxia rosea* (Gris.) Türpe (Lilloa 31:136. 1962). This name is based on *Agrostis rosea* Gris., Abh. Ges. Wiss. Göttingen **19**:253. 1874. *Calamagrostis rosea* (Gris.) Hack., ex Stuckert, (An. Mus. nac. B. Aires. Serie 3a 4. 1905) has the same basis. The combination is illegitimate because of the existence of *Deyeuxia rosea* Bor, (Kew Bull. **1954**:498. 1954) a plant from Tibet. For the Grisebach plant the name **Deyeuxia colorata** nom. nov. is proposed.

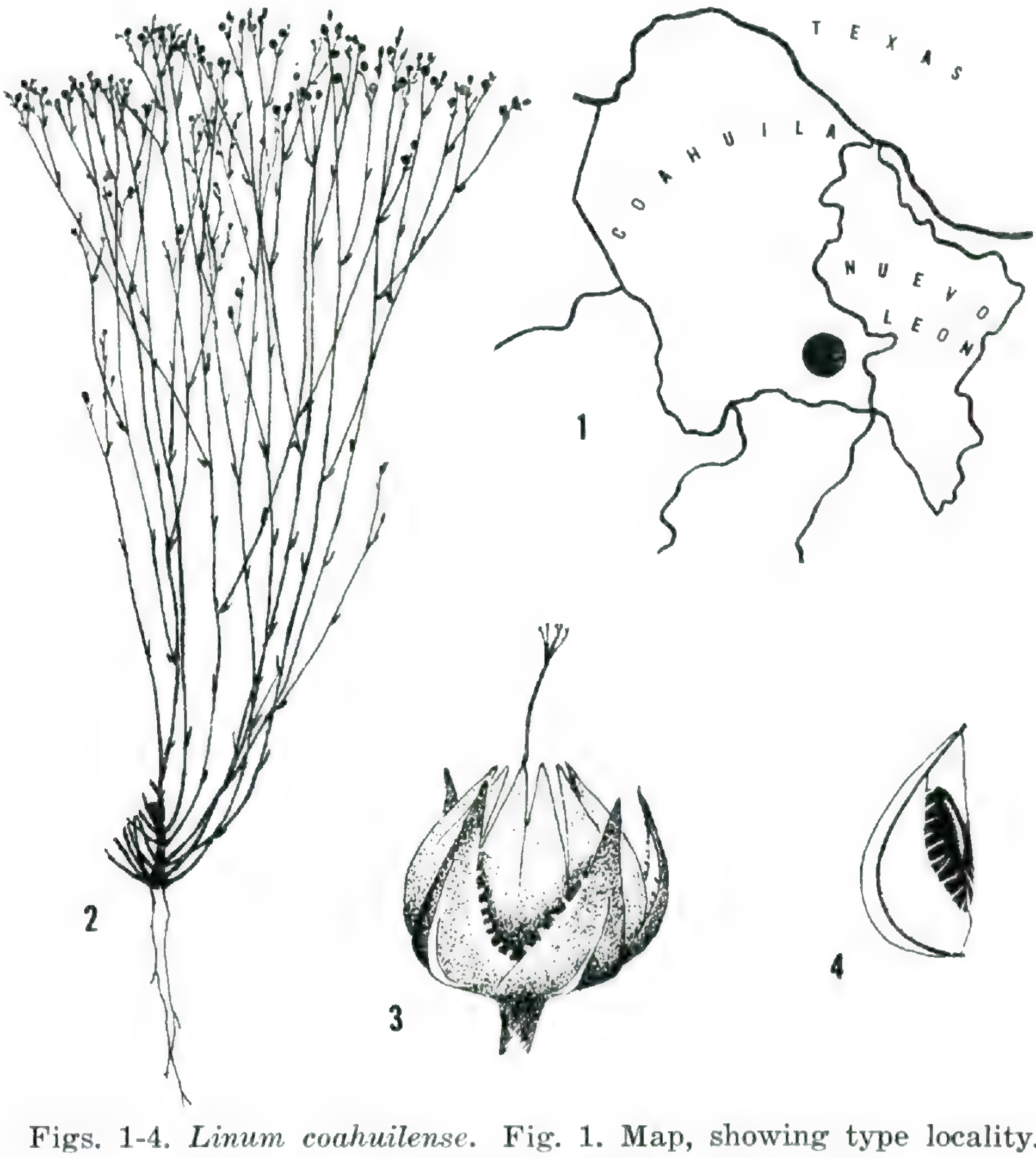
In the same paper, the combination *Deyeuxia nardifolia* (Gris.) Türpe (Lilloa 31:126. 1962) is proposed, based on *Agrostis nardifolia* Gris. An earlier combination in *Deyeuxia*, using the same basionym, is *Deyeuxia nardifolia* (Gris.) Phil., Anal. Mus. Nac. Chile. Bot. 8:83. 1891.

A. A. Beetle, plant science
unversity of wyoming, laramie.

LINUM COAHUILENSE, A NEW SPECIES FROM NORTHERN MEXICO[1]

C. Marvin Rogers

Examination of some Mexican collections of *Linum* from the herbarium of the Texas Research Foundation reveals a distinctive undescribed species (Figs. 1-4). At first glance



Figs. 1-4. *Linum coahuilense*. Fig. 1. Map, showing type locality. Fig. 2. Habit × 2/5. Fig. 3. Fruit × 8. Fig. 4. Carpel × 8.

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[1]Contribution No. 105 from the Department of Biology, Wayne State University.

it might be mistaken for a much-branched plant of *L. rupestre* (A. Gray) Engelm., a species it also resembles in having tricolpate pollen and in fruit shape and dehiscence. These two species may be fairly closely related but *L. coahuilense* differs from *L. rupestre* in several ways, notably in lacking stipular glands and in possessing united styles. The tricolpate pollen, as well as other features, distinguishes the new species from members of the *L. rigidum* and *L. sulcatum* complexes. The possession of united styles distinguishes it from all other North American species except *L. longipes* Rose and the *L. mexicanum* complex, from which it differs markedly in habit, as well as in possessing conspicuously glandular-toothed sepals and very small, alternate leaves.

Linum coahuilense C. M. Rogers, sp. nov.

Glaucum, ramosissimum; habitus et fructus Lino rupestri similis, sed stylis ex parte coalitis differt glandulis stipularibus egens.

Glabrous, glaucous annual or more probably perennial herb, about 4 dm. tall, much-branched throughout; leaves alternate, linear, the larger 11-13 mm. long and 1-1.2 mm. wide; stipular glands none; inflorescence paniculate, more or less diffuse; sepals 2-3 mm. long, glandular-toothed; petals ca. 4-5 mm. long, brownish-red upon drying; stamens alternating with two very low deltoid staminodia; pollen subspherical, tricolpate; fruit broadly ovate, pointed, 2.4-2.8 mm. high, 2.3-2.6 mm. in diam., freely dehiscing nearly to the base into 10 segments; septa sparsely, but conspicuously ciliate along the inner margins; false septa incomplete; styles 1.4-1.7 mm. long, partially united.

Presently known only from the type collection.

Type: In friable red sandy shale on north-facing slope near Las Barrancas, 10 miles west of Saltillo, route #60 [now #40], Coahuila, Mexico. Plants very glaucous. *D. S. Correll & I. M. Johnston 21403*, May 3, 1959 (LL).

DETROIT, MICHIGAN

CONOBEA MULTIFIDA; A NEW RECORD FOR NEBRASKA. On August 10, 1963, specimens of *Conobea multifida* (Michx.) Benth. [*Leucospora* (Michx.) Nutt.] were collected *(R. J. Lemaire 2505)* at the Middle Channel Platte River about seven miles south by southwest of mid-town Grand Island, Nebraska. Twelve specimens were collected from approximately fifty observed along a one-quarter mile segment of the nearly dry riverbed. The plants were two to six inches tall and were growing in the deep sands of the riverbed. They were found from approximately one-eighth to three-eighths of a mile southwest of the northernmost bridge across the Middle Channel Platte River on U. S. Highway 281.

Insofar as the writer has been able to determine, from examination of pertinent literature and the principal herbaria of Nebraska, Kansas, and Missouri, this represents the first collection of this genus in Nebraska. Various manuals indicate that this plant is found in the states immediately east and south of Nebraska but not in Nebraska or the states immediately north and west.

Some of the associated plants observed were *Cyperus diandrus* Torr., *C. acuminatus* Torr. & Hook., *Echinochloa crusgalli* (L.) Beauv., *Chenopodium salinum* Standl., and seedings of *Populus deltoides* Marsh.

Specimens have been deposited in the herbaria of the University of Nebraska, Lincoln; the U. S. National Museum, Washington, D. C.; Kansas State University, Manhattan; the University of Kansas, Lawrence; Florida State University, Tallahassee; and the University of Southwestern Louisiana, Lafayette.

ROBERT J. LEMAIRE, U. S. FISH AND WILDLIFE SERVICE,
GRAND ISLAND, NEBRASKA

A SYSTEMATIC STUDY OF THE GENUS BAHIA (COMPOSITAE)[1]

WILLIAM L. ELLISON

8. *Bahia schaffneri* S. Wats.

8a. *Bahia schaffneri* S. Wats. var. *schaffneri*

Bahia schaffneri S. Wats., Proc. Am. Acad. 26:142. 1891. Holotype examined (GH): "Sandy plains near San Luis Potosí." May 18, 1889, San Luis Potosí, Mexico, *C. G. Pringle 3028*.

Plants annual, 5-15 cm. tall. Stems decumbent, more or less pubescent, spreading from a slender taproot, 2-3 mm. in diameter, the ultimate branches culminating in 1-5 monocephalic peduncles; peduncles 1-6 cm. long, pubescent (occasionally with stipitate glands near the involucre). Leaves opposite, becoming alternate in the upper branches, ternately 1-4 times divided into linear segments (the latter 0.2-1 mm. wide), 1-2.5 cm. long, pubescent, impressed punctate with globules of exudate within the depressions (occasionally the punctate condition is only barely perceptible). Mature heads (including florets) 5-8 mm. high, 10-15 mm. in diameter. Involucre broadly campanulate; involucral bracts sparingly pubescent (occasionally with stipitate glands) with globules of exudate few or absent, 8-14 in 1-2 series, reflexing with age, membranous margins occasionally purple, 4-5 mm. long, 1.3-2 mm. wide, lanceolate or oblanceolate with the apex obtuse or acute and the midrib weakly developed or absent. Receptacle flat, alveolate or fimbrillate, 1.2-1.6 mm. in diameter. Ray florets 3-7, yellow, pistillate, fertile; ligule 2.6-3.5 mm. long, 1-2.3 mm. wide, oval (rarely oblong or ovate) with a notched or undulate apex; tube 0.2 mm. in diameter, 1.5-2 mm. long with few to numerous short stipitate glands. Disc florets 50-70, perfect and fertile, yellow, 2.5-3.5 mm. long; tube stipitate-glandular, 0.2 mm. in diameter, 1-1.3 mm. long; throat funnelform-campanulate, 0.7-1 mm. long; lobes 5, reflexed at maturity, 0.5-0.8 mm. long, farinose on the inner surfaces; anthers 1-1.5 mm. long, partially exserted at maturity; style branches flattened, 0.5-0.8 mm. long with prominent stigmatic lines along the upper margins (occasionally only weakly discernible), reflexed at maturity, apices obtuse with papillose enlargements; achenes 2.2-3(-3.5) mm. long, narrowly obpyramidal, 4-sided, brown to black, hispid on the angles of the lower quarter with hairs about 0.2 mm. long, hispidulous on the angles and the faces of the upper portion; pappus of 8 scarious, obovate scales; scales 0.7-1.5 mm. long, 0.5-0.9 mm. wide, thickened at the base but without midribs. Chromosome numbers, $n = 8$ and 10.

DISTRIBUTION: Calcareous loam and silty-clays of igneous

[1]Concluded from page 215 (April-June 1964).

origin mostly on gravelly mesas and slopes in the states of San Luis Potosí, Zacatecas, Guanajuato and Aguascalientes, 5500-8000 ft. (Fig. 54). Principal flowering dates July-September.

As constituted here, *B. schaffneri* consists of two varieties: var. *schaffneri* and var. *aristata*. Rydberg (1914) recognized these taxa as two species, distinguishing the latter by the excurrent midribs of its pappus scales and by its absence of impressed-punctate foliage. I found all specimens of var.

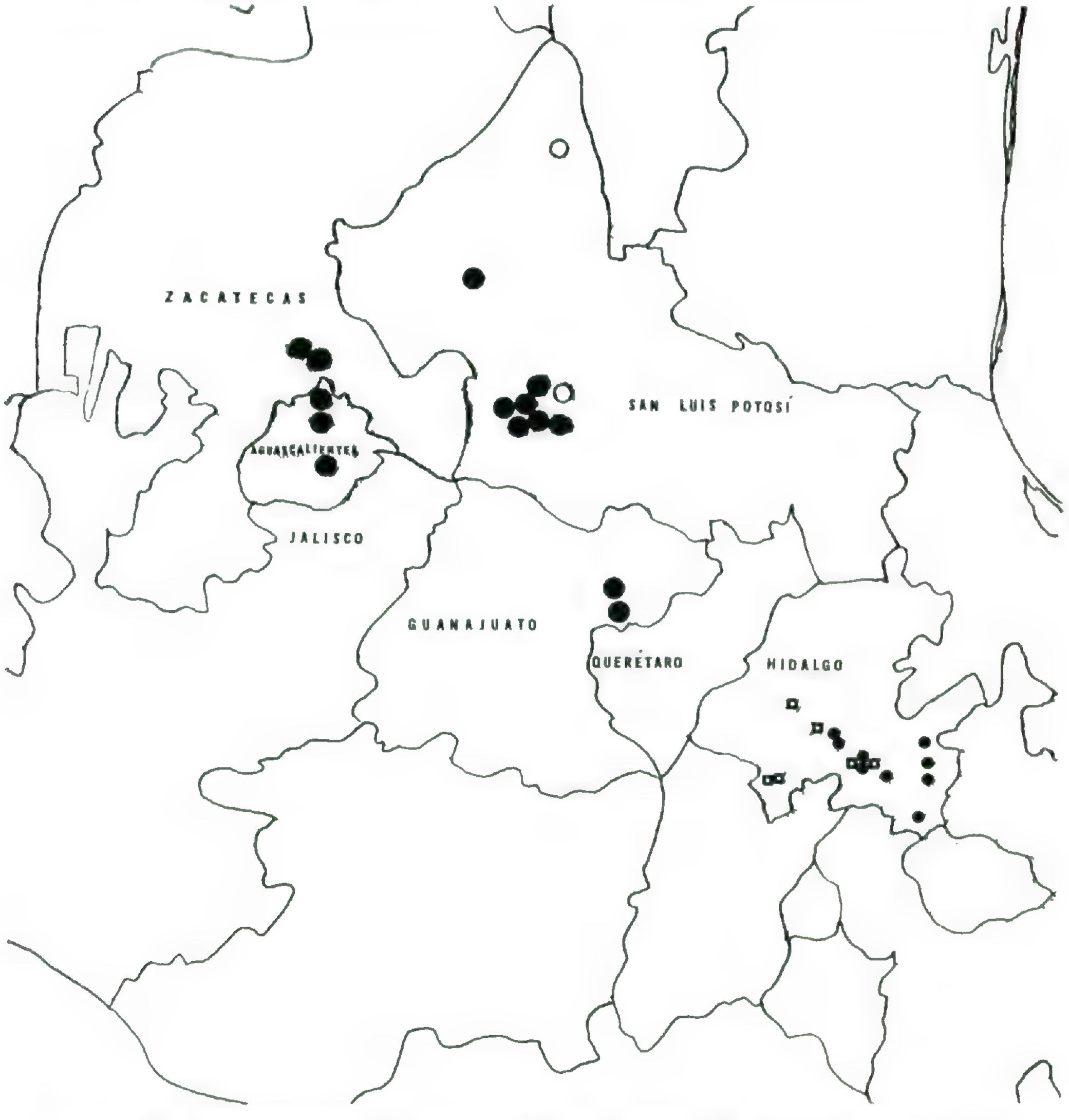

Fig. 54. Map showing distribution of *B. pringlei*, small open squares; *B. schaffneri* var. *schaffneri*, large closed circles; *B. schaffneri* var. *aristata*, large open circles; *B. xylopoda*, small closed circles.

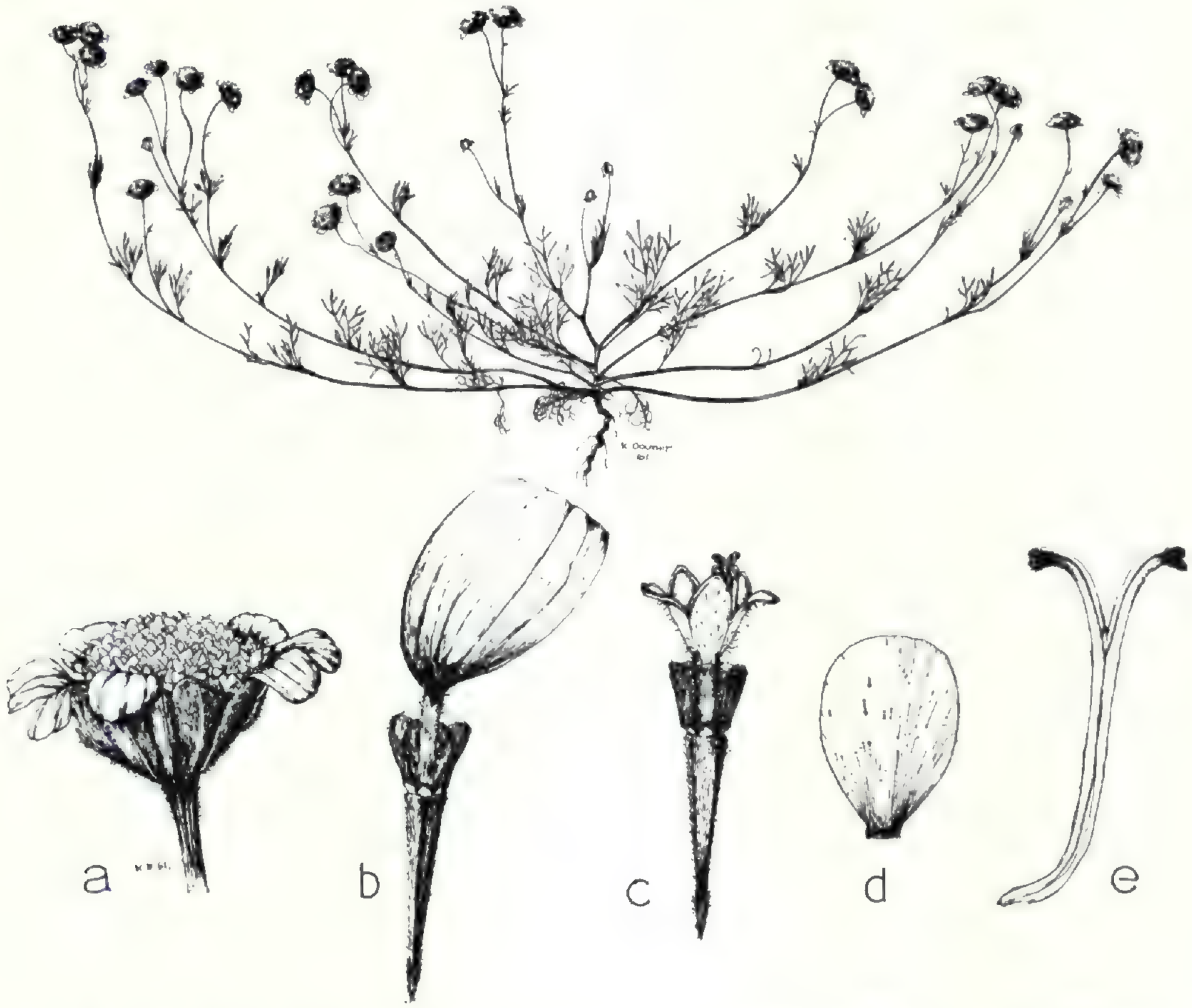

Fig. 55. *B. schaffneri* var. *schaffneri* (*Pringle 3266*, GH). Entire plant, × 2/7. a. Head, × ca. 3. b. Ray floret, × ca. 4. c. Disc floret, × ca. 5. d. Pappus scale, × ca. 11. e. Style branches, × ca. 11.

aristata and occasional individuals of var. *schaffneri* to be more or less puncticulate, although the latter taxon commonly has a better defined punctate condition.

Although the aristate costa is the most distinguishing character of var. *aristata*, other morphological features serve to differentiate between the two varieties. Var. *aristata* usually has a conspicuously longer disc-floret tube, is generally a more robust plant with larger heads, having longer achenes with a variable pubescence and longer pappus scales (excluding the excurrent midribs). Var. *schaffneri* is apparently restricted to sandy loams of calcareous and igneous derivation, while var. *aristata* has been reported only from gypsiferous and alkaline soils. It should be noted, though, that I. M. Johnston (1941) does not list var. *aristata* as a

gypsiferous plant. Whereas future work may indicate a reversal of opinion, I do not believe the maintenance of two species, at least as judged by morphological data, to be warranted at this time, although the taxa should be formally recognized as distinct.

An additional problem is posed by the occurrence of two chromosome numbers in var. *schaffneri*. The $n = 8$ counts were obtained from populations more or less grouped about San Luis Potosí, whereas the single $n = 10$ count was found in a population near Aguascalientes. No significant morphological differences could be detected between the specimens from these two regions.

REPRESENTATIVE COLLECTIONS: MEXICO. AGUASCALIENTES: 7 miles N. of Rincon de Romos, 6500 ft., Oct. 6, 1955, *M. C. Johnston 2911* (TEX). 15 miles N. of Rincon de Romos, 2 miles from Zacatecas line, 6900 ft., Oct. 2, 1955, *M. C. Johnston 2845* (TEX). Near Aguascalientes, Oct. 9, 1903, *J. N. Rose & J. H. Painter 7774* (US). GUANAJUATO: 54 miles S. of San Luis Potosí on Hwy. 57, 6800 ft., Aug. 26, 1960, *W. L. Ellison & A. Garcia 71* (TEX). 9 miles N. of Queretaro state line on road from Queretaro to San Luis Potosí, 6000 ft., Sept. 20, 1959, *M. C. Johnston 4029A* (TEX). SAN LUIS POTOSÍ: 11 miles E. of San Luis Potosí on Hwy. 86, 6300 ft., Aug. 26, 1960, *W. L. Ellison & A. Garcia 65* (TEX). 12 miles E. of San Luis Potosí on Hwy. 86, 6300 ft., Aug. 26, 1960, *W. L. Ellison & A. Garcia 68* (TEX). San Luis Potosí, 5950 ft., Aug. 23, 1926, *G. L. Fisher 134* (US). San Luis Potosí, 13 miles from Benito Juarez monument on road to Rio Verde, 6000 ft., Oct. 23, 1959, *J. Graham & M. C. Johnston 4469* (TEX). 13 miles from San Luis Potosí on road to Rio Verde, 6000 ft., Sept. 20, 1959, *M. C. Johnston 4037A* (TEX). Charcas, July-Aug., 1934, *C. L. Lundell 5556* (ARIZ, MICH, UC, US). Near San Luis Potosí, 6000-8000 ft., 1878, *C. C. Parry & E. Palmer 494* (F, US). Near San Luis Potosí, Sept. 7, 1890, *C. G. Pringle 3266* (F, GH, MICH, UC, US). Km. 15 on Hwy. from San Luis Potosí to Tampico, 1750 m., w/o date, *Rzedowski 3277* (US). Penasco Station, 1850 m., w/o date *Rzedowski 3432* (F, TEX, US). 1877, *J. G. Schaffner 327*, (F, GH). 1879, *J. G. Schaffner 753* (MICH, US). ZACATECAS: 9 miles S. E. of Zacatecas on Hwy. 45, 7900 ft., Oct. 2, 1955, *M. C. Johnston 2840A* (TEX). 2 miles N. of Ojocaliente, 6800 ft., Oct. 6, 1955, *M. C. Johnston 2922* (TEX).

8b. *Bahia schaffneri* S. Wats. var. *aristata* (Rydb.), comb. nov.

Bahia aristata Rydb., N. Am. Fl. 34:36. 1914. Holotype examined (GH): "Alkaline plains." Hacienda of Angostura, San Luis Potosí, Mexico, July 11, 1891, *C. G. Pringle 5127*.

Plants annual, 5-30 cm. tall. Stems decumbent, spreading from a slender taproot, 2-3 mm. in diameter, each terminal branch culminating in 1-5 monocephalic peduncles 1-7 cm. long, variously pubescent or nearly glabrous. Leaves opposite becoming alternate on the upper branches, ternately 1-4 times divided into linear segments about 1 mm. wide, 1-3 cm. long, pubescent, non- or slightly punctate with few globules of exudate. Mature heads (including florets) 6-10 mm. high, 12-18 mm. in diameter. Involucre broadly campanulate; involucral bracts pubescent with globules of exudate few or absent, 14-18 in 2 series, reflexing with age, margins membranous and occasionally purple, 3-6 mm. long, 1-2.5 mm. wide, lanceolate or oblanceolate with the apex obtuse or acute and midrib weakly developed or absent. Receptacle flat, alveolate, about 1.5 mm. in diameter. Ray florets 4-8, yellow pistillate, fertile; ligule 3-3.5 mm. long, 1.5-1.8 mm. wide, oblong-ovate with a notched or undulate apex; tube 0.2 mm. in diameter, 1.5-1.8 mm. long with few to numerous short stipitate glands. Disc florets 50-85, perfect and fertile, yellow, 3-3.6 mm. long; tube stipitate glandular, 0.2 mm. in diameter, (1.2-)1.6-1.8 mm. long; throat funnelform-campanulate, 0.7-1.3(-2) mm. long; lobes 5, reflexed at maturity, 0.6-0.8(-1.3) mm. long, farinose on the inner surfaces; anthers 1-1.3 mm. long, partially exserted at maturity; style branches flattened, 0.5-0.7 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices obtuse with papillose enlargements; achenes 2.5-4.8 mm. long, narrowly obpyramidal, 4-sided, brown to black, markedly hispid on the angles of the lower quarter, the hairs up to 0.4 mm. long, glabrate or merely hispidulous on the upper portion; pappus of 8 scarious obovate scales; scales with a prominent midrib extending as an excurrent awn, 1.2-2 mm. long without the awn, 2-3.5 mm. long with awn, 0.6-1 mm. wide. Chromosome number not determined.

DISTRIBUTION: Apparently rare, occurring on gypsiferous and alkaline soils of San Luis Potosí, 6000-6500 ft. (Fig. 54). Principal flowering dates July-September.

SPECIMENS EXAMINED: MEXICO. SAN LUIS POTOSÍ: Just S. of Cedral on road from Matehuala N. to San Miguel, on state boundary, Sept. 11-12, 1938, *I. M. Johnston 7595* (GH, US). Between San Tiburcio and Angostura, July, 1911, *C. A. Purpus 5161* (F, GH, UC, US).

9. *Bahia oppositifolia* (Nutt.) DC.

Trichophyllum oppositifolium Nutt., Gen. N. Am. Pl. 2:167. 1818. A possible type was examined (PH): "Upper Louisiana," w/o date, *Nuttall s.n.* This location refers to the Louisiana Purchase Territory, which accords with the known distribution of the species. *Helenium oppositifolium* (Nutt.) Spreng., Syst. Veg. 3:573. 1826. *Bahia oppositifolia* (Nutt.) DC., Prodr. 5:656. 1836. *Eriophyllum oppositifolium* (Nutt.) Heynh., Nom. Bot. Hort. 310. 1840. *Eriophyllum oppositifolium*

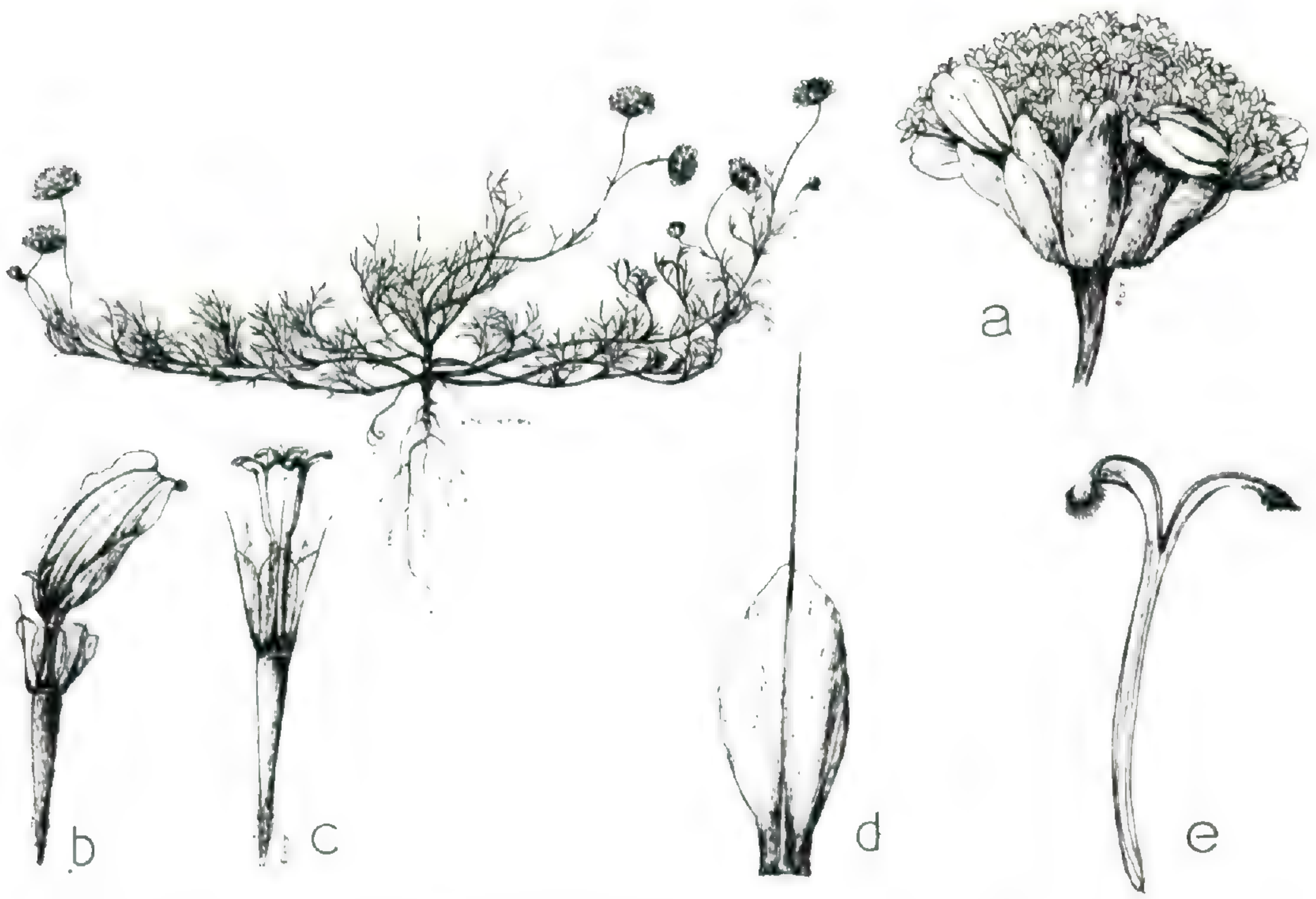

Fig. 56. *B. schaffneri* var. *aristata* (*Johnston 7595*, US). Entire plant, × 2/7. a. Head, × ca. 3. b. Ray floret, × ca. 4. c. Disc floret, × ca. 4. d. Pappus scale, × ca. 9. e. Style branches, × ca. 12.

(Nutt.) Kuntze, Rev. Gen. Pl. 1:337. 1891. *Picradeniopsis oppositifolia* (Nutt.) Rydb., in Britton Man. 1008. 1901.

Plants perennial, 5-20 cm. tall. Stems herbaceous or somewhat suffrutescent, 1-numerous and erect, arising adventitiously from lateral roots, 1-3 mm. in diameter, oppositely branched, ultimate branches terminating in 1-6 monocephalic peduncles, cinereous, pubescent and farinose with few globules of exudate; peduncles 0.5-2 cm. long. Leaves opposite, ternately divided into linear segments 1-3 mm. wide, the segments entire or again divided (occasionally simple and entire at the base of the stem), 1.5-4.5(-5) cm. long, cinereous, pubescent, impressed punctate with globules of exudate in the depressions. Mature heads (including florets) 6-8 mm. high, 8-16 mm. in diameter. Involucre campanulate; involucral bracts variously pubescent with few to numerous globules of exudate, 7-9 in 1-2 series, partially reflexing with age, margins membranous, 4-8 mm. long, 1-4 mm. wide, oblong or ovate (rarely obovate) with the apex obtuse, more or less keeled with the midrib prominent. Receptacle somewhat convex, naked, 1.5-2 mm. in diameter. Ray florets 4-7, yellow, pistillate, fertile; ligule 2.5-3.5(-6) mm. long, 1.8-2.5 mm. wide, oblong or oval, the apex undulate; tube about 0.5 mm. in diameter, 1.3-1.6 mm. long with numerous short stipitate glands. Disc florets 30-40, perfect and fertile, yellow, regular, 3-5 mm. long; tube stipitate glandular about 0.5 mm. in diameter, 1-2 mm.

long; throat campanulate, 1.5-2 mm. long; lobes 5, reflexed at maturity, 0.7-1 mm. long; anthers 1.5-1.8 mm. long, partially exserted at maturity; style branches flattened, 0.8-1.2 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices obtuse with papillose enlargements; achenes 3-5 mm. long, narrowly obpyramidal, 4-sided, brown to black, glandular-puberulent; pappus of 8-9 scarious oblong or oval scales; scales with an obtuse apex (rarely lanceolate with percurrent or excurrent midrib), 0.8-1.2(-2) mm. long, (0.2-)0.5-0.8 mm. wide, thickened at the base, the midrib extending about ¾ the length of the scale.

DISTRIBUTION: Clayey flats, gravelly hillsides and sandy loam soils on the prairies of Montana, Wyoming, western North and South Dakota and Nebraska, Colorado and New Mexico (two specimens, one from Arizona and the other from Kansas, are considerably removed from the main distributional areas), 3000-7500 ft., (Fig. 52). Principal flowering dates, June-September.

B. oppositifolia and *B. woodhousei* have been distinguished from one another in the past by only two characters; namely, superficial processes on the achenes, and shape of pappus scales. Glandular-puberulent and hispidulous achenes were found to be consistent characters of *B. oppositifolia* and *B. woodhousei* respectively. Whereas lanceolate pappus scales were found in all specimens of *B. woodhousei*, exceptions to the obovate or ovate scales described for *B. oppositifolia* were encountered. Ten specimens with lanceolate pappus scales were found in this latter taxon: Colorado: *Eastwood s.n.*, *Knowlton 77*, *Palmer s.n.* Montana: *Anderson s.n.*, *Kelsey s.n.*, *Williams 56*. New Mexico: *Cockerell s.n.*, *Goddard 884*. Wyoming: *Johnson s.n.*, *Kelsey s.n.* No geographic pattern or other observable character(s) was found to be associated with this shape of pappus scale; the lanceolate scales may therefore be considered to represent an anomalous condition due to a widespread but infrequently encountered gene or gene-combination in *B. oppositifolia*.

The two species are sympatric in Colorado and New Mexico (and Arizona?). No intergrades from this area were encountered, but it should be noted that intergrades between two taxa as strikingly similar as are these would be difficult to determine except through intensive population

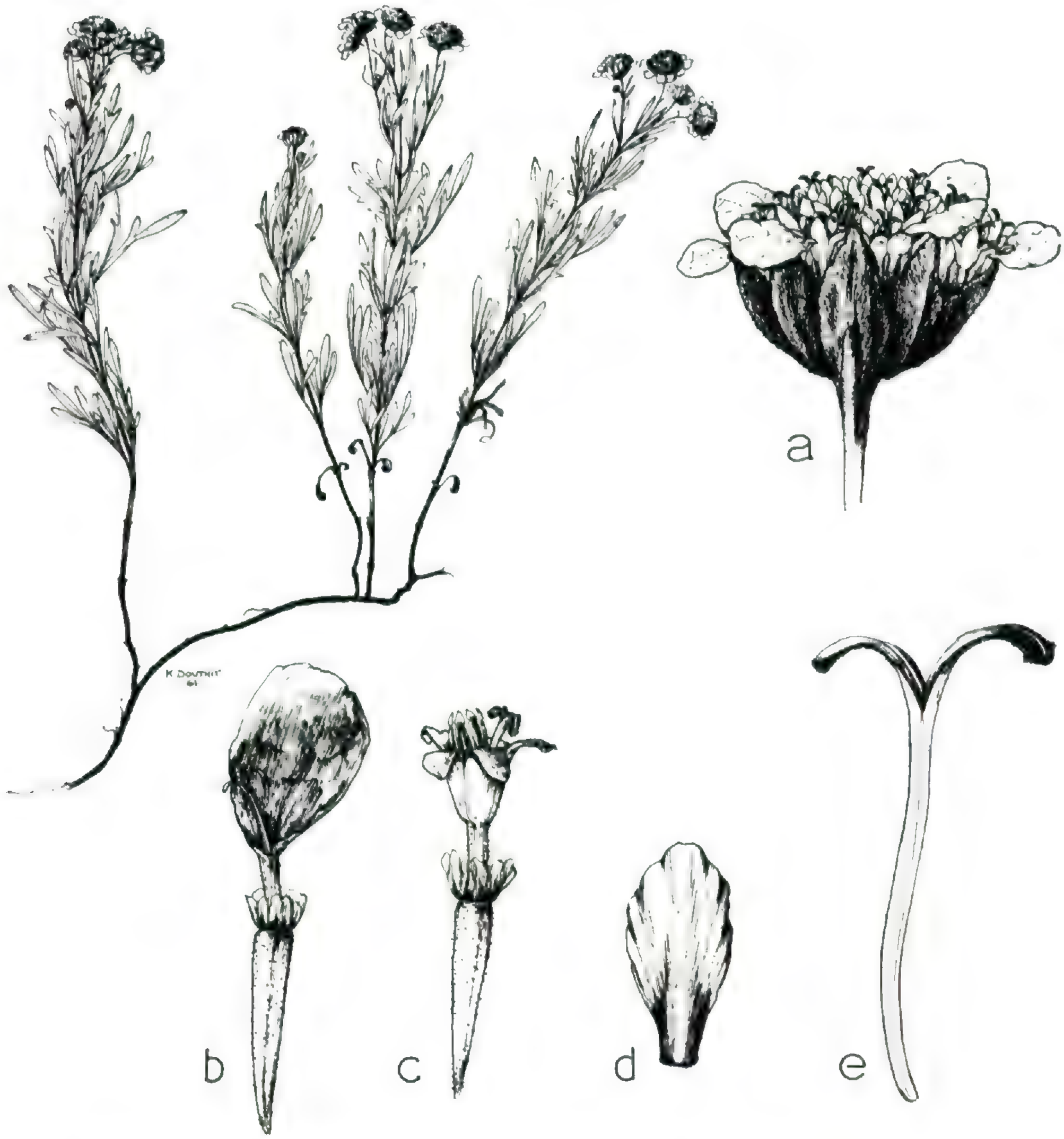

Fig. 57. *B. oppositifolia* (*Sheldon 16*, US). Entire plant part, × 2/7. a. Head, × ca. 2. b. Ray floret, × ca. 4. c. Disc floret, × ca. 4. d. Pappus scale, × ca. 18. e. Style branches, × ca. 18.

analyses. Indeed, one may wonder whether or not we are dealing with a single widespread species having a few genes controlling but one or two readily observable morphological characters. However, in addition to the key characters used by previous workers to distinguish these taxa, I have noted that *B. oppositifolia* is often more pubescent, has larger ligules and has wider corolla tubes than *B. woodhousei*.

Until further investigation including intensive field study

provides positive data for altering their taxonomic status, I believe it best to take a conservative stand and recognize the two species.

REPRESENTATIVE COLLECTIONS: ARIZONA. COCONINO CO: Flagstaff, 6900 ft., July 23, 1947, *C. F. Deaver 2304* (CAS). COLORADO. ARAPAHOE CO.: Ft. Logan, 5600 ft., July, 1934, *Cletus 269* (F). BOULDER CO.: Near South Boulder, 6000 ft. Aug. 14, 1878, *M. E. Jones 609* (F). DENVER CO.: Denver, 1616 m., Sept. 9, 1920, *R. Duthie & I. W. Clokey 3950* (CAS, DS, MICH, UC, US). Denver, Sept. 14, 1916, *A. Eastwood s.n.* (CAS). EL PASO CO.: Colorado Springs, July 2, 1926, *H. C. Benke 4305* (US). FREMONT CO.: Canon City, June, 1877, *T. S. Brandegee s.n.* (F). HUERFANO CO.: La Veta, July 13, 1896, *C. L. Shear 3567* (US). JEFFERSON CO.: 2 miles W. of Broomfield, June 27, 1954, *W. A. Weber 8737* (ARIZ, CAS, DS, TEX, UC). KIT CARSON CO.: Hugo, Aug. 17, 1875, *H. N. Patterson s.n.* (F). LARIMER CO.: Fort Collins, 5500 ft., July 8, 1884, *C. S. Sheldon 16* (DS, F, US). LAS ANIMAS CO.: 5 miles W. of Garcia, June 25, 1935, *L. Williams 2280* (UC, US). PUEBLO CO.: Pueblo, Aug., 1913, *L. H. Pammel s.n.* (TEX). WELD CO.: New Windsor, July 2, 1901, *G. E. Osterhout 2373* (UC). Mt. Golden, South Table, June 17, 1896, *F. H. Knowlton 77* (US). Colorado Territory, w/o date, *E. Palmer s.n.* (US). KANSAS. SEDGWICK CO.: Wichita, 1890, *M. A. Carleton s.n.* (F). MONTANA. Aug., 1888, *F. W. Anderson s.n.* (US). BIG HORN CO.: Fort Custer, July 24, 1889, *E. A. Mearns 174* (US). CASCADE CO.: Great Falls, July 28, 1906, *J. W. Blankenship 776* (F, UC, US). Great Falls, July 7, 1888, *R. S. Williams 56* (US). LEWIS & CLARK CO.: 1 mile N. of Wolf Creek, July 2, 1948, *C. L. Hitchcock 17952* (UC). Helena, w/o date, *F. D. Kelsey s.n.* (UC). SWEET GRASS CO.: Wreck Creek, Greycliff, 1230 m., June 16, 1912, *W. W. Eggleston 8000* (US). NEBRASKA. DAWES CO.: Whitney, July 13, 1893, *B. W. Everman s.n.* (F). NEW MEXICO. BERNALILLO CO.: Albuquerque, Aug. 19, 1883, *H. H. Rusby s.n.* (F, UC). COLFAX CO.: 0.5 miles N. of Santa Fe Forks on road to Raton, 5500 ft., July 6, 1927, *D. R. Goodard 884* (MICH, UC). Vicinity of Ute Park, 2200-2900 m., Sept. 9, 1916, *P. C. Standley 14591* (DS, US). LINCOLN CO.: Gray, 6000-6500 ft., Sept. 2, 1900, *F. S. & E. S. Earle 405* (US). MORA CO.: Wagon Mound, Aug. 26, 1886, *C. G. Pringle s.n.* (F). RIO ARRIBA CO.: Opposite San Juan, 5675 ft., June 24, 1897, *A. A. & G. Heller 3755* (DS, US). SANDOVAL CO.: Bernalillo, 1555 m., Aug. 22, 1953, *Arsene 21841* (UC). SAN MIGUEL CO.: Near Las Vegas, 1899, *T. D. A. Cockerell s.n.* (US). SANTA FE CO.: Vicinity of Santa Fe, Pankey's ranch 2000 m., Nov. 7, 1926, *G. Arsene & A. Benedict 15930* (F). Vicinity of Santa Fe, 2225 m., July 6, 1911, *P. C. Standley 6473* (US). UNION CO.: Near Okla. line, N. W. of Kenton, Okla., June 11, 1948, *C. M. Rogers 5969* (TEX, US). NORTH DAKOTA. BOWMAN CO.: Bowman, June 28, 1918, *O. A. Stevens s.n.* (CAS). GOLDEN VALLEY CO.: Sentinel Butte, July 3, 1934, *H. C. Hanson s.n.* (UC, US). SOUTH

DAKOTA. FALL RIVER CO.: Cottonwood Creek, July 29, 1911, *S. S. Visher 2578* (F). HARDING CO.: Cane Hills, Aug. 2, 1910, *S. S. Visher 341* (F). SHANNON CO.: Cannon, July 31, 1924, *W. H. Over 16245* (US). WYOMING. YELLOWSTONE PARK, July, 1890, *F. D. Kelsey s.n.* (DS). Dallas, Aug. 17-18, 1905, *F. W. Johnson s.n.* (US). ALBANY CO.: Sybille, July 3, 1900, *A. Nelson 7376* (DS, UC, US). FREMONT CO.: Bonneville, Tough Creek, June 26, 1910, *A. Nelson 9428* (UC). LARAMIE CO.: 5 miles W. of Cheyenne, Sept. 16, 1934, *B. Maguire & B. L. Richards, Jr. 13359* (UC). NATRONA CO.: Seventeen Mile Well on Salt Creek Road, July 9, 1901, *L. N. Goodding 220* (DS, F). PLATTE CO.: Hartville, June 20, 1901, *A. Nelson 8327* (DS, UC, US).

10. *Bahia woodhousei* (Gray) Gray

Achyropappus woodhousei Gray, Proc. Am. Acad. 6:546. 1866. Holotype examined (GH): New Mexico, 1865, *Woodhouse s.n. Schkuhria woodhousei* (Gray) Gray, Proc. Am. Acad. 9: 199. 1874. *Bahia woodhousei* (Gray) Gray, Proc. Am. Acad. 19:28. 1883. *Eriophyllum woodhousei* (Gray) Kuntze, Rev. Gen. Pl. 1:337. 1891. *Picradeniopsis woodhousei* (Gray) Rydb., Bull. Torr. Club 37:333. 1910.

Plants perennial, 5-15 cm. tall. stems herbaceous or somewhat suffrutescent, 1-numerous and erect, arising adventitiously from lateral roots, 1-3 mm. in diameter, oppositely branched, ultimate branches terminating in 1-6 monocephalic peduncles, cinereous, sparingly pubescent and farinose with few to numerous globules of exudate; peduncles 1-2 cm. long. Leaves opposite, ternately divided into linear segments 1-2 mm. wide, the latter entire or again divided, 1-3 cm. long, sparingly pubescent, cinereous, impressed punctate with globules of exudate in the depressions. Mature heads (including florets) 4-8 mm. high, 8-12 mm. in diameter. Involucre campanulate; involucral bracts puberulent and somewhat farinose with numerous globules of exudate, 8-10 in 1-2 series, partially reflexing with age, 2.5-7 mm. long, 1.5-3 mm. wide, oblong or obovate (oval) with the apex obtuse, more or less keeled with the midrib prominent, margins membranous. Receptacle flat or slightly convex, naked, about 2 mm. in diameter. Ray florets 5-9, yellow to orange, pistillate, fertile; ligule 2.2-4 mm. long, 1-1.4 mm. wide, oblong or somewhat spatulate with a notched or 2-3-lobed apex; tube about 0.3 mm. in diameter, 1-1.4 mm. long with numerous stipitate glands. Disc florets 25-40, perfect and fertile (rarely merely staminate or neutral), yellow to orange, regular (frequently zygomorphic peripherally), 2.5-5 mm. long; tube and base of throat with numerous stipitate glands; tube 0.3-0.4 mm. in diameter, 1-2 mm. long; throat campanulate, 1-2 mm. long; lobes 5, reflexed at maturity, 0.5-1 mm. long; anthers 1.5-1.8 mm. long, partially exserted at maturity; style branches flattened, 0.7-0.9 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices obtuse with papillose enlargements; achenes 3-4 mm. long, narrowly obpyramidal,

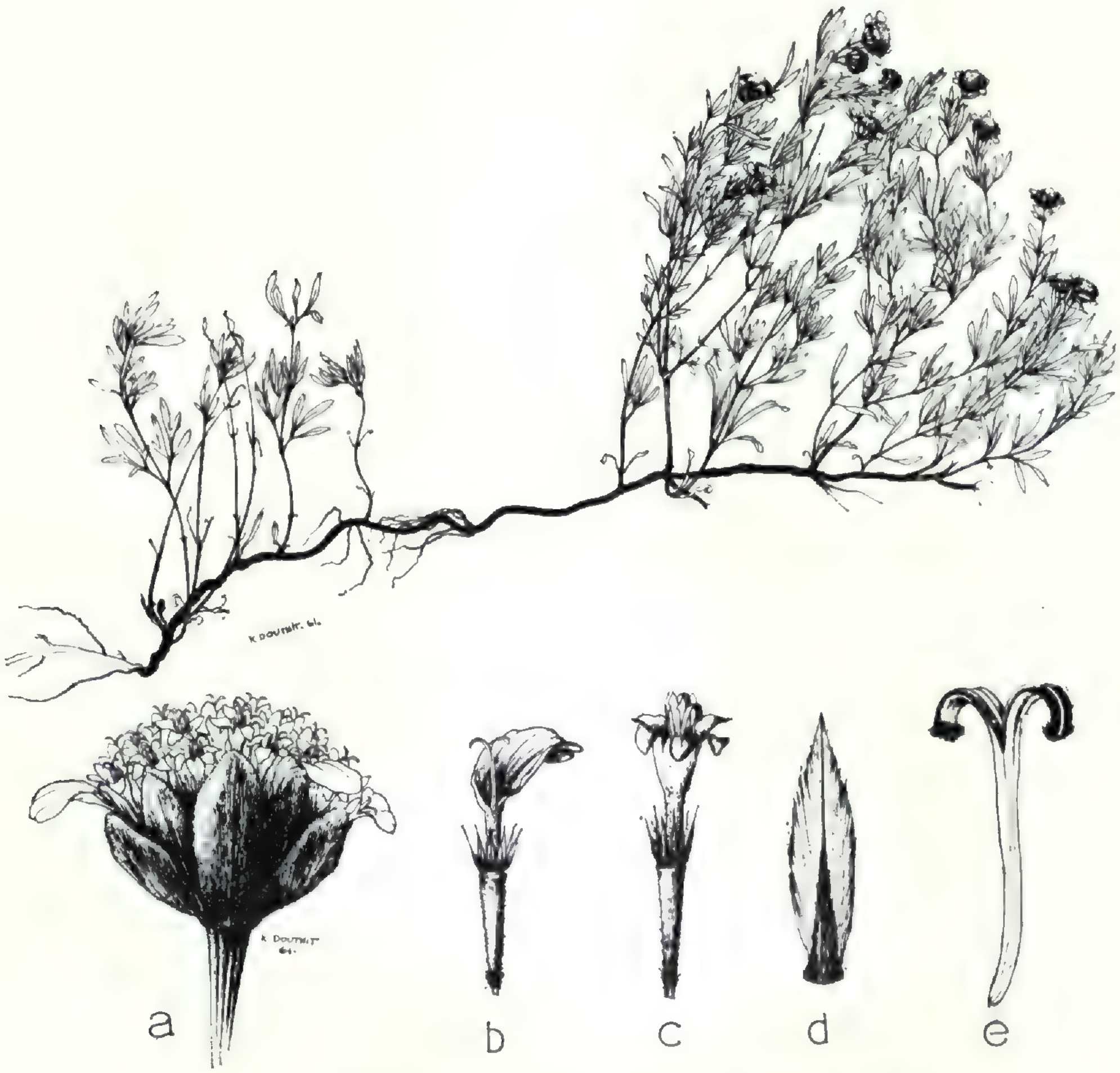

Fig. 58. *B. woodhousei* (*Waterfall 9686*, ARIZ). Entire plant part, × 2/7. a Head, × ca. 2. b. Ray floret, × ca. 3. c. Disc floret, × ca. 3. d. Pappus scale, × ca. 18. e. Style branches, × ca. 18.

4-sided, brown to black, hispid on the angles of the base, otherwise hispidulous; pappus of 8-9 scarious lanceolate scales; scales 0.6-2 mm. long (subequal or conspicuously unequal on any one achene), 0.2-0.5 mm. wide, thickened at the base, midrib prominent extending to the apex (occasionally slightly excurrent).

DISTRIBUTION: Clayey or sandy soils on the prairies of eastern Colorado, western Kansas and Oklahoma, New Mexico, Arizona and northwestern Texas (also reported from extreme western Texas: Warnock, 1960), 3500-5100 ft., (Fig. 52). Principal flowering dates, May-October.

In comparing this species with *B. oppositifolia*, Rydberg indicated that "the flowers are of a much lighter color in *P.*

woodhousei [sic], the rays being ochroleucous or straw-colored." It is interesting to note, however, that "orange" flowers have been reported for *B. woodhousei (Shinners 8134* and *8184)*. I saw no living specimens of *B. oppositifolia* and living plants from only one population of *B. woodhousei (Ellison 176);* the flowers of the latter were a yellowish-orange.

The populational relationships of this species to *B. oppositifolia* are discussed under the latter species.

REPRESENTATIVE COLLECTIONS: ARIZONA. NAVAJO CO.: Dagg's Reservoir, Oct. 13, 1955, *C. C. Michaels 815* (CAS). COLORADO. BACA CO.: 8 miles S. W. of Pritchett on Hwy. 160, June 14, 1948, *C. M. Rogers 6001* (US). ELBERT CO.: 15 miles S. W. of Limon, June 25, 1937, *M. Ownbey 1304* (DS, GH, UC). WASHINGTON CO.: Akron, July 5, 1909, *H. L. Shantz 966* (US). YUMA CO.: Yuma, Aug. 19, 1909, *H. L. Shantz 935* (US). KANSAS. MEADE CO.: 3 miles E. & 6 miles S. of Meade, June 14, 1951, *W. H. Horr & McGregor 3857* (US). NEW MEXICO. MCKINLEY CO.: Zuni, July 21, 1906, *E. O. Wooton s.n.* (US). QUAY CO.: Nara Visa, June 10, 1911, *G. L. Fisher s.n.* (UC, US). TAOS CO.: Taos, Aug. 18, 1910, *E. O. Wooton s.n.* (US). UNION CO.: Sierra Grande, Aug., 1903, *A. H. Howell 234* (US). OKLAHOMA. BEAVER CO.: Few miles W. of Fargon, Aug. 18, 1950, *G. J. Goodman & R. W. Kelting 5370* (TEX). CIMARRON CO.: 13 miles E. of Boise City, July 9, 1947, *U. T. Waterfall 7416* (TEX). TEXAS CO.: 5 miles N. & 24 miles W. of Guymon, May 31, 1952, *U. T. Waterfall 10801* (ARIZ, TEX). TEXAS. BAILEY CO.: 2.5 miles N. W. of Muleshoe, June 22, 1941, *V. L. Cory 37521* (GH, TEX, US). DALLAS CO.: 7 miles N. W. of Dalhart, June 25, 1945, *L. H. Shinners 8184* (TEX). HEMPHILL CO.: Canadian, July 11, 1934, *E. L. Reed 3764* (TEX). LUBBOCK CO.: Lubbock, May 27, 1930, *D. Demaree 7727* (DS, GH, US). MOORE CO.: Dumas, 3600 ft., June 10, 1945, *B. & H. Jesperson 2705* (DS, UC, US). 13 miles S. of Dumas, June 24, 1945, *L. H. Shinners 8135* (UC). PARMER CO.: 3 miles S. E. of Farwell on Hwy. 84, Sept. 30, 1960, *W. L. Ellison 176* (TEX). RANDALL CO.: 7 miles N. of Canyon, June 22, 1945, *L. H. Shinners 8047* (DS).

11. *Bahia absinthifolia* Benth.

11a. *Bahia absinthifolia* Benth. var. *absinthifolia*

Bahia absinthifolia Benth., Pl. Hartw. 18. 1839. Isotype examined (GH): Aguascalientes, Mexico, *Hartweg 128*. Photograph of holotype seen (MICH). *Eriophyllum absinthifolium* (Benth.) Kuntze, Rev. Gen. Pl. 1:336. 1891.

Plants perennial, suffrutescent, 10-35 cm. tall. Roots with occasional elongated tuberous swellings. Stems 1-3 mm. in diameter branching

from the base, each terminal branch culminating in 1-5 monocephalic peduncles, canescent or only partially clothed with short appressed hairs; peduncles 1-8 cm. long, tomentose. Leaves opposite becoming alternate on the upper stems, highly variable in form, some being lanceolate and entire, others ternately divided into narrowly linear or lanceolate segments which may be again dissected, 10-50 mm. long with segments 1-3 mm. wide, tomentulose-canescent. Mature heads 0.5-1.5 cm. high, 1-2.3 cm. in diameter. Involucre hemispheric or broadly campanulate; involucral bracts tomentose, often farinose with occasional globules of exudate beneath the tomentum, 12-15 in 2 series with 1 or more narrowly linear outer bractlets, reflexing with age, 4-8(-10) mm. long, 1-3 mm. wide, lanceolate with apex acute, obtuse or acuminate, midrib weakly discernible from the inner surface, margins membranous. Receptacle flat or slightly convex, alveolate, 1-1.8 mm. in diameter. Ray florets 9-13, yellow, pistillate, fertile; ligule 5-9(-15) mm. long, 1.5-3 mm. wide, elliptical, the apex truncate and undulate; tube 0.2 mm. in diameter and 1.5-2 mm. long with stipitate glands. Disc florets 60-80, perfect and fertile, yellow, regular, 3-4 mm. long; tube stipitate glandular, 0.2 mm. in diameter, 1-1.7 mm. long; throat funnelform-campanulate, 1-1.8 mm. long; lobes 5, reflexing at maturity, 0.5-0.8 mm. long; anthers 1.5-1.8 mm. long, partially exserted at maturity; apices obtuse with papillose enlargements; achenes 3-5.3 mm. long, narrowly obpyramidal, 4-sided, brown to black, striate, merely hispidulous on upper portion; pappus of 6-9 scarious obovate scales, scales 1.3-2 mm. long, 0.7-1.1 mm. wide, thickened at the base with midrib present or absent (when present, extending ½-¾ the length). Chromosome numbers, $n = 12$ and 24.

DISTRIBUTION: Calcareous soils in arid regions of central and northern Mexico, 5000-7800 ft., (Fig. 59). Principal flowering dates February-October.

Whereas, *B. dealbata* was first recognized as a good species by Gray, he later altered his opinion when he stated that it "evidently passes into *B. absinthifolia*." Separation of the two taxa, *B. absinthifolia* var. *absinthifolia* and *B. absinthifolia* var. *dealbata*, was made by Gray on the basis of the latter variety's more lignescent base, more whitened foliage with a pannose tomentum, broader and less-divided leaves and broader involucral bracts. In my field study and examination of herbarium specimens I could find no feature other than that of leaf width and dissection which might be considered a key character. Moreover, no correlation was found between the leaf profile and any one or group of the other characters. Statistical comparisons such as those used by

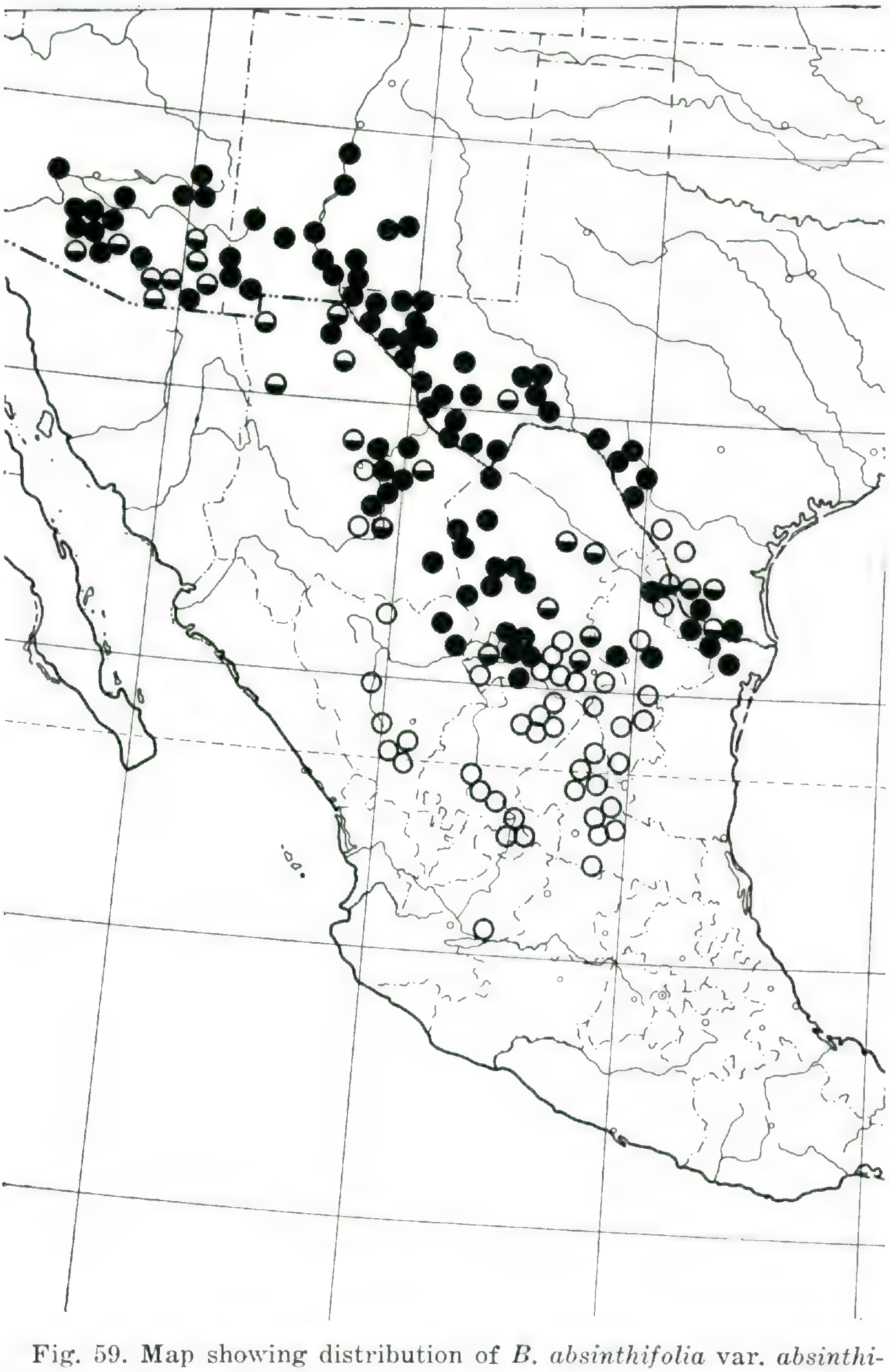

Fig. 59. Map showing distribution of *B. absinthifolia* var. *absinthifolia*, open circles; *B. a.* var. *dealbata*, closed circles; intermediate populations of the two varieties, half-closed circles.

Fig. 60. *B. absinthifolia* var. *absinthifolia* (Isotype, *Bentham 128*, GH). Entire plant, × 2/7. a. Head, × ca. 1.5. b. Ray floret, × ca. 3. c. Disc floret, × ca. 3. d. Pappus scale, × ca. 12. e. Style branches, × ca. 12.

Anderson (1934) and others were not employed in this present study but should prove to be of real value in assessing more accurately the taxonomic status of these two varieties. Based solely on leaf character, populations of *B. absinthifolia* fall into two fairly well-defined geographical areas: the narrow-leaved var. *absinthifolia* occurring in central and

northern Mexico and the broad-leaved var. *dealbata* being found predominantly in west Texas and southern New Mexico and Arizona. Intermediate populations, generally falling in a region of overlap, were observed in the field. Numerous herbarium specimens from northern Mexico, extreme southern and southwestern Texas and southern Arizona had intermediate leaf characters. Occasional individuals within the distributional "center" of var. *dealbata* were observed to have leaves as narrowly linear as those found in var. *absinthifolia*. The reverse situation was never encountered; that is, no broad- and undissected-leaved plants were found in populations near the distributional "center" of var. *absinthifolia*.

Conservatism has led me to maintain a taxonomic *status quo* with regard to these varieties. Additional chromosome-number determinations may be useful, but the present state of knowledge offers no help. It was hoped that populational chromatographic data might elucidate the problem. Although no meaningful information for rendering a taxonomic judgment resulted from the study conducted, a more intensive biochemical study might well prove fruitful.

Although a single character cannot be considered favorable for varietal delimitation, I nevertheless believe that since the character is found only in a relatively limited area and, from transplant studies, is apparently under genetic control, the two varieties should be recognized for the present. Obviously, this opinion is subject to revision when additional information is brought to bear on the problem.

REPRESENTATIVE COLLECTIONS: TEXAS. DIMMIT CO.: E. of Carrizo Springs, May 1, 1931, *M. E. Jones 28060* (CAS, DS, UC). MAVERICK CO.: Near Eagle Pass, 800 ft., April 26, 1900, *C. G. Pringle 9033* (F). MEXICO. AGUASCALIENTES: 11 mi. N. of Aguascalientes, Hwy. 45, 6100 ft., Sept. 2, 1960, *W. L. Ellison & A. Garcia 108* (TEX). Near Aguascalientes, Aug. 20, 1901, *J. N. Rose & R. Hay 6226* (US). COAHUILA: 5 mi. S. of Saltillo, Sept. 13, 1946, *F. A. Barkley 16056* (F). Road from Saltillo to Concepción del Oro, W. of Melville Station, Sept. 1-2, 1938, *I. M. Johnston 7328* (GH). 10 mi. N. of Saltillo toward Piedras Negras Oct. 14, 1959, *M. C. Johnston & J. Graham 4321* (TEX). Saltillo and vicinity, May, 1898, *E. Palmer 117* (GH, UC, US). Parras, 111.5 mi. W. of Saltillo, June 8-28, 1880, *E. Palmer 674* (GH, US).

Parras, Oct., 1910, *C. A. Purpus 4649* (F, GH, UC, US). 12 mi. S. of Jimulco, 4300 ft., Sept. 14, 1939, *F. Shreve 9409* (ARIZ, GH, MICH, UC). DURANGO: 116 mi. N. of Zacatecas, Hwy. 45, 6900 ft., Sept. 2, 1960, *W. L. Ellison & A. Garcia 116* (TEX). 63 mi. N. of Durango, Hwy. 45, 4700 ft., Sept. 3, 1960, *W. L. Ellison & A. Garcia 127* (TEX). 2 mi. N. of La Zarca, Hwy. 45, 6200 ft., Sept. 3, 1960, *W. L. Ellison & A. Garcia 130* (TEX). Crest of Sierra de Zarca, 6800 ft., Sept. 18-19, 1938, *I. M. Johnston 7773* (GH). Durango and vicinity, Sept., 1896, *E. Palmer 617* (F, GH, UC, US). JALISCO. Lake Chapal, 1905, *Mr. & Mrs. J. G. Lemmon 191* (UC). NUEVO LEÓN: 28 mi. S. of Saltillo, Hwy. 57, 6250 ft., Aug. 24, 1960, *W. L. Ellison & A. Garcia 50* (TEX). 101 mi. S. of Saltillo, Hwy. 57, 5800 ft., Aug. 24, 1960, *W. L. Ellison & A. Garcia 56* (TEX). 28 mi. S. of Nuevo Laredo on road to Monterrey, Apr. 18, 1938, *T. C. Frye & E. M. Frye 2355* (DS). 4 mi. S. of Galeana on road to Iturbide, Oct. 8, 1959, *M. C. Johnston & J. Graham 4212* (TEX). Along Pan-Am. Hwy. N. of Mamulique Pass, 1500 ft., *Mr. & Mrs. W. C. Leavenworth 750* (F). Cañon de los Capulines above San Enrique, Hacienda San José de Raices, Derrumbadero, Aug. 6, 1935, *C. H. Mueller 2362* (GH). Road between Doctor Arroyo and Matehuala, June 17-18, 1898, *E. W. Nelson 4517* (US). Doctor Arroyo, 5700 ft., Aug. 24, 1940, *F. Shreve & E. R. Tinkham 9658* (ARIZ, GH). SAN LUIS POTOSÍ: 4 mi. N. E. of San Luis Potosí, Aug. 29, 1947, *F. A. Barkley, G. L. Webster & J. B. Paxson 800* (TEX). 22 mi. S. of Matehuala, Hwy. 57, 4100 ft., Aug. 25, 1960, *W. L. Ellison & A. Garcia 58* (TEX). 9 mi. N. of San Luis Potosí, 6100 ft., Aug. 25, 1960, *W. L. Ellison & A. Garcia 64* (TEX). 38 mi. S. of San Luis Potosí. Hwy. 57, 6000 ft., Aug. 26, 1960, *W. L. Ellison & A. Garcia 70* (TEX). Road from San Luis Potosí to Matehuala (via Huizachal), 14 mi. S. of Matehuala, Sept. 10-11, 1938, *I. M. Johnston 7520* (GH). At Km. 22, 11 mi. from San Luis Potosí on road to Rio Verde, 5800 ft., Sept. 20, 1959, *M. C. Johnston 4038A* (TEX). 10 mi. N. of Nuñez on San Luis-Matehuala Hwy., Oct. 23, 1959, *M. C. Johnston & J. Graham 4465* (TEX). Charcas, July-Aug., 1934, *C. L. Lundell 5359* (ARIZ, MICH, US). 22° N. lat., 6000-8000 ft., 1878, *C. C. Parry & E. Palmer 493* (DS, F, GH. US). Km. 20, Hwy. between San Luis Potosí and Antiguo Morelos, 1800 m., Sept. 9, 1954, *Rzedowski 4226* (F, TEX). 14 mi. S. E. of Matehuala, 4600 ft., Sept. 10, 1938, *F. Shreve 8695* (ARIZ, MICH, US). TAMAULIPAS: Near Miquihuana, Aug. 8, 1941, *L. R. Stanford, K. L. Retherford & R. D. Northcraft 786* (ARIZ, DS, GH. UC). Near reservoir of Miquihuana, July 10, 1949, *L. R. Stanford, L. A. Taylor & S. M. Lauber 2375* (MICH, TEX, UC, US). ZACATECAS: 1 mi. N. of Zacatecas, Hwy. 45. 7800 ft., Sept. 2, 1960, *W. L. Ellison & A. Garcia 112* (TEX). 68 mi. N. of Zacatecas, Hwy. 45, 6800 ft., Sept. 2, 1960, *W. L. Ellison & A. Garcia 114* (TEX). Road from Cardona S. W. to Sierra Hermosa, Sept. 3-4. 1938, *I. M. Johnston 7379* (GH, US). Vicinity of Cedros, June, 1908, *J. E. Kirkwood 116* (F, GH).

REPRESENTATIVE COLLECTIONS OF INTERMEDIATES:

ARIZONA. COCHISE CO.: Paradise, 5500 ft., Sept. 26, 1907, *J. C. Blumer 2186* (F, US). Tucson, Dec. 4, 1902, *Thornber s.n.* (ARIZ, DS). TEXAS: BREWSTER CO.: 15 mi. E. of Marathon, Hwy. 90, Sept. 12, 1959, *W. L. Ellison & B. L. Turner 41* (TEX). EL PASO CO.: El Paso, Oct. 18, 1931, *E. Whitehouse 8446* (DS, MICH). JIM HOGG CO.: Hwy. between Gueria and Randado, Dec. 5, 1948, *Tharp, Johnson, & Webster 48-100* (TEX). STARR CO.: Rio Grande City, 200 ft., Apr. 20, 1924, *R. Runyon 597* (US). WEBB CO.: Vicinity of Laredo, Oct. 22, 1913, *J. N. Rose 18042* (US). ZAPATA CO.: Near Zapata, Feb. 18, 1934, *E. U. Clover 1796* (MICH, US). MEXICO. CHIHUAHUA: 30 mi. E. of Parral, Hwy. 45, 5100 ft., Sept. 4, 1960, *W. L. Ellison & A. Garcia 135* (TEX). Mina Vieja near Santo Domingo, S. E. of Chihuahua, 7200 ft., Sept. 5, 1960, *W. L. Ellison & A. Garcia 153* (TEX). Sand dunes, Oct. 10, 1935, *H. LeSueur Mex. 450* (F, TEX). Near Casas Grandes, Aug. 30, 1899, *E. W. Nelson 6337* (GH, US). COAHUILA: Saltillo, 1600 m., May 1909, *G. Arsene 3471* (US). Road from Piedras Negras S. to Monclova, Aug. 22-24, 1938, *I. M. Johnston 7082* (GH). 4 mi. N. E. of San Lázaro, 78 mi. N. of Saltillo, 2000 ft., Oct. 7, 1959, *M. C. Johnston & J. Graham 4185* (TEX). Del Carmen Mts., Aug. 15, 1936, *E. G. Marsh, Jr. 671* (F, GH). Saltillo, Apr. 1-15, 1880, *E. Palmer 672* (F, GH, US). 48 mi. W. of Saltillo on road to Torreon, 3800 ft., Sept. 15, 1938, *F. Shreve 8750* (ARIZ, GH, MICH, UC). Vicinity of Santa Elena Mines, foothills of Sierra de las Cruces, June 26, 1941, *R. M. Stewart 634* (GH). NUEVO LEÓN: 36 mi. N. E. of Sabinas Hidalgo, March 24, 1944, *F. A. Barkley 14574* (TEX, US). 28 mi. S. of Nuevo Laredo on road to Monterrey, Apr. 18, 1939, *T. C. Frye & E. M. Frye 2355* (GH, UC).

11b. *Bahia absinthifolia* Benth. var. *dealbata* (Gray) Gray

Bahia dealbata Gray, Mem. Am. Acad. II. 4:99. 1849. Holotype examined (GH): "Valley between Mapimi and Guajuquilla," 1847, Chihuahua, Mexico, Dr. *Gregg*. A paratype was likewise examined: May 8, 1847, Cadenas, Mexico, Dr. *Gregg*. *Bahia absinthifolia* Benth. var. *dealbata* (Gray) Gray, Pl. Wright. 1:121. 1852. *Picradeniopsis dealbata* (Gray) Woot. & Standl., Contr. U. S. Nat. Herb. 16:192. 1913.

Plants perennial, suffrutescent, 10-40 cm. tall. Roots with occasional elongated tuberous swellings. Stems 1-3 mm. in diameter branching from the base, each terminal branch culminating in 1-5 monocephalic peduncles, canescent or only partially clothed with short appressed hairs; peduncles 1-8 cm. long, tomentose. Leaves opposite becoming alternate on the upper stems, highly variable in form, some being narrowly to broadly lanceolate and entire or toothed with others ternately divided into narrow-to-broad linear segments which may themselves be divided, 10-40(-50) mm. long, 1-15 mm. wide at the point of maximum width, tomentulose-canescent. Mature heads 0.5-1.5 cm. high, 1-2.5 cm. in diameter. Involucre hemispheric or broadly campanulate; involucral bracts tomentose and farinose with few globules

Fig. 61. *B. absinthifolia* var. *dealbata* (*E. & G. 138*, TEX). Entire plant, × 2/7. a. Head, × ca. 1.5. b. Ray floret, × ca. 3. c. Disc floret, × ca. 3. d. Pappus scale, × ca. 12. e. Style branches, × ca. 12.

of exudate beneath the tomentum, 12-16 in 2 series with 1 or more outer bractlets, reflexing with age, 5-9 mm. long, 1-4 mm. wide, lanceolate with apex acute to ovate or frequently acuminate, midrib weakly discernible from the inner surface, margins membranous. Receptacle flat or slightly convex, alveolate, 1.5-1.8 mm. in diameter. Ray florets 10-13, yellow, pistillate, fertile; ligule 5-12 mm. long, 2-3.5 mm. wide, oblong or elliptical, the apex undulate and truncate; tube 0.2-0.3 mm. in diameter and 1.5-2 mm. long with stipitate glands. Disc florets 55-70,

perfect and fertile, yellow, regular, 3.5-4.5 mm. long; tube stipitate glandular, 0.2-0.3 mm. in diameter, 1.2-1.5 mm. long; throat funnelform-campanulate, 1.2-2.5 mm. long; lobes 5, reflexing at maturity, 0.3-0.8 mm. long; anthers 1.6-1.8 mm. long, partially exserted at maturity; style branches flattened, 0.7-1 mm. long with prominent stigmatic lines on the upper margins, reflexed at maturity, apices obtuse with papillose enlargements; achenes 2.5-5.5 mm. long, narrowly obpyramidal, 4-sided, brown to black, striate, hispid on lower 1/3 with hairs 0.5-0.8 mm. long, merely hispidulous on upper portion; pappus of 6-9 scarious obovate scales; scales 1.2-2 mm. long, 0.6-0.8 mm. wide, thickened at the base with midrib present or absent (when present, extending 1/2-3/4 the length). Chromosome numbers, $n = 12$, 24 and 36.

DISTRIBUTION: Calcareous soils in arid regions of northern Mexico, western Texas, southern New Mexico and southern Arizona, 1000-7000 ft., (Fig. 59). Principal flowering dates February-October.

REPRESENTATIVE COLLECTIONS: ARIZONA. COCHISE CO.: Vicinity of Douglas, May 22, 1907, *L. N. Goodding 2271* (UC). GRAHAM CO.: Between Solmonville & Clifton, 4.7 mi. S. of Greenlee Co. line, 4000 ft., Oct. 7, 1942, *C. B. Wolf & P. C. Everett 11,401* (ARIZ, TEX, UC). MARICOPA CO.: Near Tempe, May 4, 1926, *G. J. Harrison 1793* (US). PIMA CO.: Mesas, Tucson, May 17, 1903, *J. J. Thornber 392* (ARIZ, CAS, DS, UC, US). PINAL CO.: Mammoth, Aug., 1891, *G. C. Nealley 274* (US). NEW MEXICO. DONA ANA CO.: Mesa W. of Organ Mts., Oct. 17, 1903, *E. O. Wooton s.n.* (ARIZ, MICH, UC, US). GRANT CO.: Lake Valley, 1914, *I. M. Beals s.n.* (US). HIDALGO CO.: Lordsburg, May 15, 1919, *A. Eastwood 8586* (CAS). OTERO CO.: Alamogordo, June, 1915, *B. P. Baker s.n.* (US). SOCORRO CO.: Near Socorro, July, 1881, *H. H. Rusby 207* (F, MICH). TEXAS. BREWSTER CO.: 48 mi. S. of Alpine, Sept. 12, 1959, *W. L. Ellison & B. L. Turner 27* (TEX). 48 mi. S. of Alpine, Hwy. 118, *W. L. Ellison & B. L. Turner 28* (TEX). Terlingua, Sept. 12, 1959, *W. L. Ellison & B. L. Turner 34* (TEX). CULBERSON CO.: ca. 8 mi. N. of Van Horn, 4000 ft. Aug. 24, 1950, *B. H. Warnock 9322* (LL). EL PASO CO.: El Paso, Apr. 17, 1884, *M. E. Jones 3720* (ARIZ, CAS, DS, F, US). HUDSPETH CO.: 5 mi. W. of Van Horn, Beach Mts., 4100 ft., Sept. 7, 1955, *B. H. Warnock 13624* (LL, TEX). PECOS CO.: Hwy. 290, 32 mi. E. of Ft. Stockton, Sept. 11, 1959, *W. L. Ellison & B. L. Turner 15* (TEX). STARR CO.: Rio Grande City, Feb. 28, 1930, *B. C. Tharp 7305* (MICH, TEX, US). TERRELL CO.: 26 mi. E. of Sanderson, Hwy. 90, Sept. 12, 1959, *W. L. Ellison & B. L. Turner 42* (TEX). VAL VERDE CO.: Canyon of Pecos R., 1 mi. above mouth at crossing of Hwy. 90, March 29, 1947, *R. McVaugh 7697* (DS, F, MICH, TEX). MEXICO, CHIHUAHUA: 78 mi. N. of Parral, Hwy. 45, 5100 ft., Sept. 4, 1960, *W. L. Ellison & A. Garcia 138* (TEX). Samalayuca, Sept. 23, 1886, *C. G. Pringle 1031* (F, US). 21 mi. S. of Ojinaga, 3000 ft., Aug. 1,

1937, *F. Shreve 8100* (ARIZ). 3 km. N. E. mouth of Cañon del Rayo, towards N. end of Sierra del Diablo ca. lat. 27°20′ N., July 25, 1941, *R. M. Stewart 852* (GH). 8 mi. W. of Guimbalete, road to Escalon, July 24, 1939, *S. S. White 2035* (MICH). COAHUILA: 55 mi. W. of Monterrey, Hwy. 40, 3800 ft., Aug. 24, 1960, *W. L. Ellison & A. Garcia 49* (TEX). General Cepeda, 10,500 ft., July 21, 1944, *G. B. Hinton 16578* (GH, US). Potrero del Cuervo Chico, 3 mi. S. of Tanque La Luz, Aug. 28, 1941, *I. M. Johnston 8576* (GH). Piachos Colorados, ca. lat. 28°36′, Aug. 11, 1940, *I. M. Johnston & C. H. Mueller 124* (GH). Torreon, Nov. 21, 1925, *S. Juzepczuk 681* (US). El Carmen, Oct. 10-19, 1935, *H. LeSueur Mex. 351* (F, GH, TEX). Cuatro Cienegas, Aug. 23, 1939, *E. G. Marsh 2045* (F, GH). 4 mi. S. W. of Hipolito, Aug. 29, 1939, *C. H. Mueller 3022* (GH, LL, MICH, UC). Cerro de Cypriano, June, 1910, *C. A. Purpus 4470* (UC). Paila, Rt. 40, Aug. 12, 1959, *H. F. L. Rock M-483A* (TEX). 1 km. N. W. of Noria de San Juan, road from Guimbalite S. E. to Acatita, Oct. 14, 1942, *R. Santos 3010* (GH). 30 km. W. of Cuatro Cienegas, Cañon de Jara, E. of Socorro, Feb. 1-5, 1941, *A. H. Schroeder 37* (GH). Hipolito, 3300 ft., Aug. 30, 1938, *F. Shreve 8506* (ARIZ). 9 mi. W. of Cuatro Cienegas on road to El Oro, July 21-22, 1939, *S. S. White 1934* (ARIZ, GH, MICH). Hipolito, June 14, 1936, *F. L. Wynd & C. H. Mueller 55* (ARIZ, GH). DURANGO: 7 mi. S. E. of Conejos, May 4, 1939, *D. S. Correll & I. M. Johnston 21437* (LL). Durango and vicinity, Sept. 1896, *E. Palmer 701* (GH, US). NUEVO LEÓN: Km. 216 from Matamoros, 4 mi. W. of bridge over Rio San Juan on Monterrey-Reynosa Hwy., Oct. 18, 1959, *M. C. Johnston 4353A* (TEX). 27 mi. W. of Monterrey on Saltillo Hwy., Oct. 14, 1959, *M. C. Johnston & J. Graham 4317* (TEX). Monterrey, 1924, *C. R. Orcutt 1291* (US).

12. *Bahia xylopoda* Greenman

Bahia xylopoda Greenman, Proc. Am. Acad. 34:577. 1899. Holotype examined (GH): "Bare hills above Pachuca, 8500 ft.," July 30, 1898, Hidalgo, Mexico, *C. G. Pringle 6931*. Isotypes examined (F, UC, US).

B. ehrenbergii Schultz-Bip. ex Rydb., N. A. Fl. 34:35. 1914, isotype examined (GH): Mexico, *O. Ehrenberg 362*.

Plants perennial, suffrutescent, 10-30 cm. tall. Rootstocks 2-5(-15) mm. in diameter near the crown; roots ramifying horizontally and producing adventitious shoots, the smaller rootlets having occasional elongated tuberous swellings. Stems erect or somewhat decumbent, 1-3(-7) mm. in diameter, branching from the base with each terminal branch culminating in 1-6 monocephalic peduncles, occasionally farinose at the base, variously pubescent and usually becoming increasingly glandular in the upper stems; peduncles 1-7(-12) cm. long, more or less pubescent or with numerous stipitate glands and few to many globules of exudate adnate to the surface. Leaves opposite becoming alternate in the upper stems, ternately divided into trifid, pinnatifid or bipinnatifid linear segments generally about 1 mm. wide, 1-4 cm.

long, pubescent, impressed punctate with globules of exudate in the depressions. Mature heads (including florets) about 10 mm. high, 15-20 mm. in diameter. Involucre broadly turbinate-campanulate; involucral bracts variously pubescent, occasionally farinose, frequently with stipitate glands (these occasionally being purple) and small globules of exudate, 11-18 in 2(-3) series, reflexing with age, margins membranous, occasionally tinged with purple or red (rarely completely colored), 3.5-7 mm. long, 1-2 mm. wide, lanceolate or obovate with the apex obtuse and the midrib weakly discernible or absent. Receptacle flat or slightly convex, alveolate, 1-2 mm. in diameter. Ray florets 9-15, yellow, pistillate, fertile; ligule 4-8 mm. long, 2-4 mm. wide, oval or oblong with truncate irregularly lobed apex; tube 0.2-0.5 mm. in diameter, 1.5-2.5 mm. long with numerous stipitate glands. Disc florets 60-120, perfect and fertile, yellow, regular (rarely slightly zygomorphic peripherally), 3-5 mm. long; tube stipitate glandular, 0.25 mm. in diameter, 1.2-2 mm. long; throat funnelform, 1-2 mm. long; lobes 5, reflexed at maturity, 0.5-1 mm. long; anthers 1.5-1.8 mm. long, partially exserted at maturity; style branches flattened, 0.7-1.2 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices more or less obtuse with papillose enlargements; achenes 3.2-5.5 mm. long, narrowly obpyramidal, 4-sided, brown to black, hispid on the angles of the lower quarter with hairs to 0.8 mm. long, hispidulous on the sides and angles of the upper portion (occasionally almost glabrous), the hairs generally about 0.2 mm. long; pappus of 8 scarious obovate (occasionally spatulate) scales; scales 1.3-3 mm. long, 0.5-1.2 mm. wide, thickened at the base with a definite costa extending about 2/3 the length of the scales (occasionally little or no costa, rarely with prominent excurrent midribs). Chromosome number, $n = 11$.

DISTRIBUTION: Sandy or clay loam of volcanic origin or rocky calcareous mesas and slopes in disturbed habitats of southern Hidalgo, 7000-8500 ft., (Fig. 54). Principal flowering dates June-November.

Greenman, in his original description of *B. xylopoda*, states that "this species is nearly related to *B. pringlei* Greenm., but is distinguished readily by the longer achenes, narrower scales of the pappus, and also, according to Mr. Pringle, by the entire absence of running roots." With reference to this quotation, attention should be called to the characteristics for "distinguishing readily" between the taxa. Achenal length is so variable in the two species that it cannot be used to characterize either taxon except perhaps in a statistical way, although there is a tendency for longer

achenes in *B. xylopoda*. A close examination of the root systems of the two species, both in the field and from herbarium specimens, indicated that *B. pringlei* and *B. xylopoda* both have "running roots." Morphologically, I found but one consistent feature which provides a ready key character for separation of the species; namely, the width-to-length ratio of the pappus scales. Expressed on a percentage basis, i.e., width/length × 100, *B. pringlei* has values ranging from 75 to 120, whereas this ratio in B. xylopoda varies from 40 to 70.

There are other overlapping character combinations such as degree of root thickness, width or leaf, degree of glandulosity and/or farinose condition, which, when coupled with the above-mentioned pappus-dimension ratio, serve to separate the two taxa on morphological grounds. Anderson and Whitaker (1934) in their discussion of speciation in *Uvularia* state that "the acknowledged discontinuity between . . . two species, taken in their entirety, is a discontinuity of combinations, reinforced by a few discontinuous differences in single characters." This is somewhat apropos to the two taxa under consideration here; i.e., the slight overlapping differences between these two species are perhaps more characteristic than the discontinuous ones, though it is on the discontinuous ones that we commonly rely for ready identification.

In addition to the exomorphic features mentioned above, the two taxa, so far as known, have different chromosome numbers; *B. xylopoda* is diploid with $n = 11$ while *B. pringlei* is tetraploid with $n = 22$.

In my field study of these taxa, four populations of *B. pringlei* were examined whereas only a single population of *B. xylopoda* was seen. Until further field work is conducted, and additional cytological, biochemical and morphological study is done, I believe a conservative approach to be indicated; that is, *B. xylopoda* and *B. pringlei* should be treated as separate species.

Emphasis should be given to the facts that both of the species are known only from the state of Hidalgo, and that

Fig. 62. *B. xylopoda* (Holotype, *Pringle 6931*, GH). Entire plant, × 2/7. a. Head, × ca. 1.5. b. Ray floret, × ca. 3. c. Disc floret, × ca. 3. d. Pappus scale, × ca. 12. e. Style branches, × ca. 12.

they are partially sympatric. No evidence of intergradation was seen by me; however, as previously indicated, inadequate field study was conducted with respect to this problem.

Attention should be called to two individuals with prominent excurrent midribs which were discovered in a population of otherwise typical *B. xylopoda (Ellison 89)*. It is probable that this character is the result of the segregation of only a few genes; if so, it should be expected in other pop-

ulations. However, this character was not found in the several populational analyses which I made of *B. pringlei.*

B. ehrenbergii is known only from the type specimen; "Mexico" is given as the locality. Careful examination indicates that it is clearly *B. xylopoda.* A single feature that is distinguishing is the lack of the characteristic globules of resinous exudate within the depressions of the punctate leaves. There being no other correlative differences, I do not consider this condition sufficient for the delimitation of a species.

SPECIMENS EXAMINED: MEXICO. MEXICO: Morelia, June 9, 1910 (locality evidently in error), *Arsene s.n.* (F). HIDALGO: Just outside Pachuca on Hwy. 105, 7700 ft., Aug. 29, 1960, *W. L. Ellison & A. Garcia 89* (TEX). Pachuca, 8200 ft., July 19, 1935, *G. L. Fisher 35246* (ARIZ, F, GH, US). Sept., 1839, *J. Gay 1870* (GH). 7 miles N. of Apam on road to Pachuquilla, 8000 ft., Sept. 16, 1959, *M. C. Johnston 4016A* (TEX). 10 miles E. of Pachuca, on road to Tulancingo, Sept. 25, 1959, *M. C. Johnston 4051A* (TEX). 8 miles S. of Actopan toward Pachuca, 7000 ft., Nov. 17, 1959, *J. Graham & M. C. Johnston 4759* (TEX). Regla, June, 1945, *M. Martinez s.n.* (F). El Arenal, W. of Hwy. at Km. 104 S. of Actopan, 2700 m., Oct. 12, 1947, *H. E. Moore, Jr. 1499* (GH). S. E. of Epazoyucan, 2500-2700 m., June 14, 1947, *H. E. Moore, Jr. 3054* (GH, UC). Pachuca, Sept. 5, 1910, *C. R. Orcutt 3920* (F, GH, US). Above Pachuca, 8500 ft., Aug. 25, 1902, *C. G. Pringle 9856* (F, GH, US). Near Metepec Station, 8300 ft., June 27, 1904, *C. G. Pringle 13029* (ARIZ, F, GH, MICH, US). Sierra de Pachuca, July 21-22, 1901, *J. N. Rose & R. Hay 5631* (F, GH, US). Sierra de Pachuca, July 20 & 24, 1905, *J. N. Rose, J. H. Painter & J. S. Rose 8749* (US).

13. *Bahia pringlei* Greenman

Bahia pringlei Greenman, Proc. Am. Acad. 32: 309. 1897. Holotype examined (GH): "Calcareous bluffs, valley near Tula, 6800 ft.," August 6, 1896, Hidalgo, Mexico, *C. G. Pringle 6407.* Isotypes examined (CAS, F, UC, US).

Plants perennial, suffrutescent, 20-30 cm. tall. Generally slender rootstock, 2-4(-8) mm. in diameter at the base, roots ramifying horizontally and vertically, frequent elongate tuberous swellings, one to few adventitious shoots. Stems more or less decumbent (occasionally erect), 1-4 mm. in diameter branching from the base, each terminal branch culminating in 1-6 monocephalic peduncles, pubescent, usually somewhat farinose; peduncles 1-6 cm. long, pubescent, globules of exudate adnate to the surface. Leaves opposite, becoming alternate on the upper stems, ternately divided into pinnatifid or bipinnatifid linear segments about 1 mm. wide, 1.5-5 cm. long, more or less densely pubescent, puncticulate with globules of exudate in the depressions.

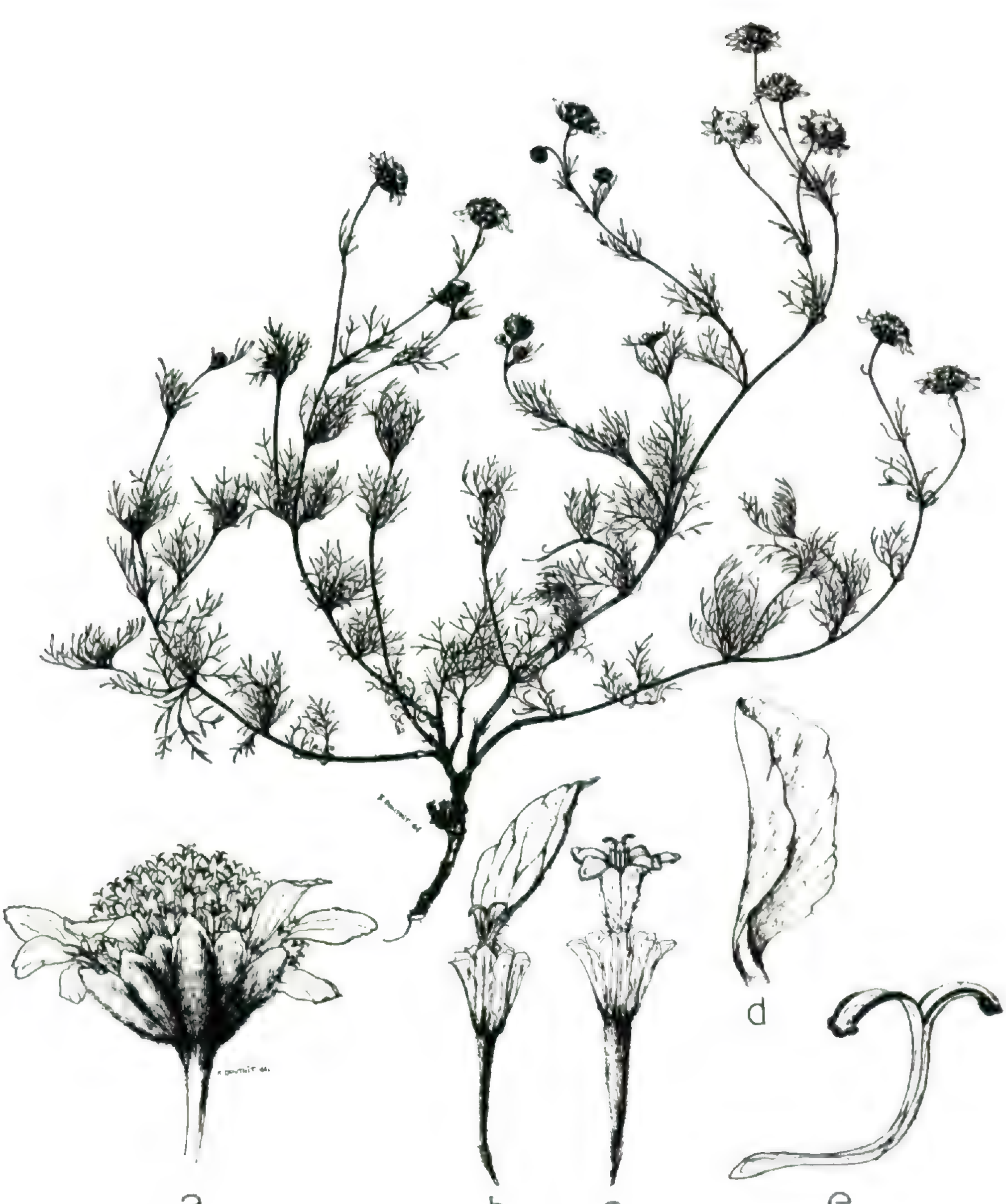

Fig. 63. *B. pringlei* (Holotype, *Pringle 6407*, GH). Entire plant, × 2/7. a. Head, × ca. 1.5. b. Ray floret, × ca. 3. c. Disc floret, × ca. 3. d. Pappus scale, × ca. 12. e. Style branches, × ca. 12.

Mature heads (including florets), 8-15 mm. high, 15-20 mm. in diameter. Involucre broadly turbinate-campanulate; involucral bracts variously pubescent and often farinose, 10-20 in 2-3 series, reflexing with age, membranous margins occasionally tinged with purple, 3-6 mm. long, 1-2.5 mm. wide, obovate or lanceolate with the apex obtuse and the midrib weakly discernible or absent. Receptacle flat, alveolate,

1-2 mm. in diameter. Ray florets 9-15, yellow, pistillate, fertile; ligule 4-6 mm. long, 2-4 mm. wide, oblong to oval with irregularly truncate notched or 3-lobed apex; tube 0.3 mm. in diameter, 1.6-2.3 mm. long with numerous stipitate glands. Disc florets 60-115, perfect and fertile, yellow, regular (rarely slightly zygomorphic peripherally), 3-6 mm. long; tube and throat with numerous stipitate glands; tube 0.3 mm. in diameter, 1-2 mm. long; throat funnelform-campanulate, 1.2-1.7 mm. long; lobes 5, reflexed at maturity, 0.6-1 mm. long; anthers 1.5-2 mm. long, partially exserted at maturity; style branches flattened, 0.7-1 mm. long with prominent stigmatic lines along the upper margins, reflexed at maturity, apices more or less obtuse with papillose enlargements; achenes 3-5 mm. long, narrowly obpyramidal, 4-sided, brown to black, hispid on the angles of the lower quarter with hairs 0.2-0.4 mm. long, hispidulous on the angles and sides of the upper part, the hairs generally being less than 0.1 mm. long; pappus of 8 scarious broadly obovate scales; scales 1.5-2 mm. long, 1-1.8 mm. wide, thickened at the base but with little or no midrib (occasionally callous-thickened for 1/2 the pappus length). Chromosome number, $n = 22$.

DISTRIBUTION: Calcareous soil or sandy loam in disturbed habitats of central and southern Hidalgo, 6500-8000 ft. (Fig. 54). Principal flowering dates July-September.

For a consideration of this species, the reader is referred to the discussion under *B. xylopoda*.

SPECIMENS EXAMINED: MEXICO. HIDALGO: 2 miles W. of Tula on Hwy. 126, 6800 ft., Aug. 27, 1960, *W. L. Ellison & A. Garcia 78* (TEX). 10 miles S. of Actopan on Hwy. 85, 8100 ft., Aug. 28, 1960, *W. L. Ellison & A. Garcia 83* (TEX). 2 miles E. of Pachuca on Hwy. 130, 7700 ft., Aug. 29, 1960, *W. L. Ellison & Garcia 86* (TEX). 10 miles N. of Actopan on Hwy. 85, 7400 ft., Aug. 29, 1960, *W. L. Ellison & A. Garcia 90* (TEX). Near Pachuca, 8000 ft., Aug. 12, 1898, *C. G. Pringle 7575* (F). Near Tula, 6800 ft., Sept. 21, 1901, *C. G. Pringle 9452* (GH, MICH, US). Dublan, 6800 ft., Sept. 16, 1902, *C. G. Pringle 9854* (F, GH, MICH, US). Ixmiquilpan, July, 1903, *C. A. Purpus 443* (UC, US).

Excluded Species

Bahia achillaeoides DC. Prodr. 5:657. 1836. = *Eriophyllum lanatum* var. *achillaeoides* (DC) Jepson.

Bahia ambigua Gray. Bot. Calif. 1:382. 1876. = *Eriophyllum ambiguum* (Gray) Gray.

Bahia alternifolia Less. ex. O. Ktze. Rev. Gen. 1:336. 1891. = *Nomen nudum.*

Bahia angustifolia (Spreng.) DC. Prod. 5:656. 1836. = *Calea angustifolia* (Spreng.) Sch.-Bip. ex Baker.

Bahia anthemoides (H. B. K.) Gray. Proc. Am. Acad. 15:40. 1879. = *Achyropappus anthemoides* H. B. K.

Bahia arachnoidea Fischer & Lallement. Ind. Sem. Hort. Petrop. 9:63. 1842. = *Eriophyllum lanatum* var. *arachnoideum* (F. & L.) Jepson.

Bahia artemisiaefolia Less. Linnaea 5:160. 1830, and 1. c. 6:253. 1831. = *Eriophyllum staechadifolium* Lag.

Bahia confertiflora DC. Prodr. 5:657. 1836. = *Eriophyllum confertiflorum* (DC.) Gray.

Bahia confertiflora var. *trifida* (Nutt.) Gray. Bot. Calif. 1:380. 1876. = *Eriophyllum confertiflorum* (DC.) Gray.

Bahia cuneata Kell. Proc. Calif. Acad. 5:49. 1873. = *Eriophyllum lanatum* var. *cuneatum* (Kell.) Jepson.

Bahia depauperata Blake. Brittonia 2:352. 1937. = **Vasquezia depauperata** (Blake) Ellison, comb. nov.

Bahia depressa M. E. Jones. Contr. West. Bot. 17:31. 1930. = *Dyssodia micropoides* (DC.) Loes.

Bahia desertorum M. E. Jones. Zoe 2:249. 1891. = *Platyschkuhria integrifolia* (Gray) Rydb.

Bahia Gilliesii Gray. Proc. Am. Acad. 19:28. 1883. = *Schkuhria multiflora* Hook. & Arn.

Bahia gracilis Hook. & Arn. Bot. Beechey Voy. 353. 1838. = *Eriophyllum lanatum* var. *integrifolium* (Hook.) Smiley.

Bahia integrifolia (Hook.) DC. Prodr. 5:656. 1836. = *Eriophyllum lanatum* var. *integrifolium* (Hook.) Smiley.

Bahia integrifolia (Gray) Macbr. Contrib. Gray Herb. n. ser. 56:39. 1918. = *Platyschkuhria integrifolia* (Gray) Rydb.

Bahia lanata (Pursh) DC. Prodr. 5:657. 1836. = *Eriophyllum lanatum* (Pursh) Forbes var. *lanatum*.

Bahia lanata Nutt. Pl. Hartweg. 317. 1849. = *Eriophyllum lanatum* var. *grandiflorum* (Gray) Jepson.

Bahia lanata Nutt. var. *achillaeoides* (DC.) Gray. Bot. Calif. 1:381. 1876. = *Eriophyllum lanatum* var. *achillaeoides* (DC.) Jepson.

Bahia lanata Nutt. var. *brachypoda* Gray Bot. Calif. 1:381. 1876. = *Eriophyllum lanatum* var. *arachnoideum* (F. & L.) Jepson.

Bahia lanata Nutt. var. *grandiflora* Gray. Bot. Calif. 1:381. 1876. = *Eriophyllum lanatum* var. *grandiflorum* (Gray) Jepson.

Bahia lanata Nutt. var. *tenuifolia* (DC.) Torr. & Gray. Fl. N. Am. 2:376. 1842. Not *Bahia tenuifolia* DC. 1836. = *Eriophyllum lanatum* (Pursh) Forbes var. *lanatum*.

Bahia latifolia Bentham, Bot. Voy. Sulph. 30. 1844. = *Eriophyllum lanatum* var. *arachnoideum* (F. & L.) Jepson.

Bahia latifolia Lindl. Jour. Hort. Soc. 8:319. 1853. = *Eriophyllum lanatum* var. *arachnoideum* (F. & L.) Jepson.

Bahia leucophylla DC. Prodr. 5:657. 1836. = *Eriophyllum lanatum* (Pursh) Forbes var. *lanatum*.

Bahia leucophylla Eaton *in* S. Wats. Bot. King's Expl., in part. 1871.

(Illegitimate name.) = *Eriophyllum lanatum* var. *integrifolium* (Hook.) Smiley.

Bahia multiflora Nutt. Trans. Am. Phil. Soc. Ser. 2, 7:373. 1841. = *Eriophyllum lanatum* var. *integrifolium* (Hook.) Smiley.

Bahia neomexicana Gray. Proc. Am. Acad. 19:27. 1883. = *Schkuhria multiflora* H. & A.

Bahia nepetaefolia Gray. Proc. Am. Acad. 5:184. 1861. = *Loxothysanus sinuatus* (Less.) B. L. Robinson.

Bahia nudicaulis Gray. Proc. Am. Acad. 19:27. 1883. = *Platyschkuhria integrifolia* (Gray) Rydb.

Bahia oblongifolia Gray. Proc. Am. Acad. 19:27. 1883. = *Platyschkuhria oblongifolia* (Gray) Rydb.

Bahia ourolepis Blake. Proc. Biol. Soc. Wash. 35:175. 1922. = **Platyschkuhria ourolepis** (Blake) Ellison, comb. nov.

Bahia palmeri (Gray) B. D. Jackson. Index Kewensis 1:264. 1895. = *Baeria palmeri* Gray. (Insertion error; formal transfer not intended by Jackson.)

Bahia palmeri Wats. Proc. Am. Acad. 24:83. 1889. = *Orochaenactis thysanocarpha* (Gray) Coville.

Bahia parviflora Gray, Bot. Calif. 1:382. 1876. = *Eriophyllum ambiguum* (Gray) Gray.

Bahia resinosa (H. & A.) DC. Prod. 6:678. 1837. = *Gutierrezia?* sp.

Bahia rubella Gray. Bot. Mex. Bound. 95. 1859. = *Eriophyllum Wallacei* Gray.

Bahia schkuhrioides (Link. & Otto) Gray. Proc. Am. Acad. 19:27. 1883. = *Schkuhria schkuhrioides* (Link. & Otto) Thellung.

Bahia sinuata Less. *in* Schlecht. & Cham. Linnaea 5:160. 1830. = *Loxothysanus sinuatus* (Less.) B. L. Robinson.

Bahia staechadifolia (Lag.) DC. Prodr. 5:656. 1836. = *Eriophyllum staechadifolium* Lag.

Bahia staechadifolia var. *californica* DC. Prodr. 5:656. 1836. = *Eriophyllum staechadifolium* Lag.

Bahia tenuifolia DC. Prodr. 5:657. 1836. = *Eriophyllum confertiflorum* (DC.) Gray.

Bahia trifida Nutt. Trans. Am. Phil. Soc. Ser. 2, 7:374. 1841. = *Eriophyllum confertiflorum* (DC.) Gray.

Bahia trolliifolia (Lag.) DC. Prodr. 5:657. 1836. = *Eriophyllum lanatum* var. *arachnoideum* (F. & L.) Jepson.

Bahia wallacei Gray Pac. R. R. Rept. 4:105. 1847. = *Eriophyllum wallacei* (Gray) Gray.

Bahia wallacei Gray, Proc. Boston Soc. Nat. Hist. 7:146. 1859. Not *B. wallacei* Gray, 1847. = *Eriophyllum ambiguum* Gray.

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Literature Cited

Anderson, E. and T. W. Whitaker, 1934. Speciation in *Uvularia*. Jour. Arnold Arboretum 15:28-41.

Blake, S. F., 1960. Compositae. In: Arizona Flora by Kearney, T. H. and R. H. Peebles. Univ. Calif. Press.

Carlquist, Sherwin, 1956. On the generic limits of *Eriophyllum* (Compositae) and related genera. Madroño 13:226-239.

Clausen, Jens, 1951. Stages in the evolution of plant species. New York. Cornell University Press. 206 pp.

Constance, L., 1937. The genus *Eriophyllum* Lag. Univ. Calif. Publ. Bot. 18:69-135.

Cronquist, A., 1955. Phylogeny and taxonomy of the Compositae. Amer. Midl. Nat. 53:478-511.

De Candolle, A. P., 1836. Prod. 5:656-658.

Ellison, W. L., R. E. Alston and B. L. Turner, 1962. Methods of presentation of crude biochemical data for systematic purposes, with particular reference to the genus *Bahia* (Compositae). Amer. Jour. Bot. 6:599-604.

Gray, A., 1849. Mem. Am. Acad. II. 4:104.

———, 1874. Proc. Am. Acad. 9:198-199.

———, 1884. Proc. Am. Acad. 19:22-29.

———, 1884. Syn. Fl. 1(2):333.

———, 1886. Syn. Fl. N. Am. 1(2):331-334.

Heiser, C. B., Jr., 1945. A revision of the genus *Schkuhria*. Ann. Mo. Bot. Gard. 32:265-278.

Johnston, I. M., 1941. Gyposophily among Mexican desert plants. Jour. Arnold Arboretum 2:145-170.

Lanjouw, J., and F. A. Stafleu, 1956. Index Herbariorum, Part I, The Herbaria of the World. Utrecht, Netherlands.

Nuttall, T., 1818. Gen. N. Am. Pl. 2:167.

———, 1841. Trans. Am. Phil. Soc. II 7:377.

Raven, P. H. and D. W. Kyhos, 1961. Chromosome numbers in Compositae. II. Helenieae. Amer. Jour. Bot. 48:842-850.

Rock, H. F. L., 1957. A revision of the vernal species of Helenium (Compositae). Rhodora 59:101-216.

Rydberg, P. A., 1914. Helenieae. Bahianae. N. Amer. Flora 34:31-43.

Shinners, L. H., 1951. Notes on Texas Compositae VIII. Field and Laboratory 19(3):135-136.

Shinners, L. H., 1959. Species of *Laphamia* transferred to *Perityle* (Compositae-Helenieae). Southwestern Nat. 4(4):204-206.

Skinner, C. G., F. D. Talbert, and W. Shive, 1958. Effect of 6-(substituted) purines and gibberellin on the rate of seed germination. Plant Physiology 33:190-194.

Small, J., 1919. The origin and development of the Compositae. London. William Wesley & Son. 334 pp. (Reprinted from The New Phytologist, Vol. 16-18, 1917-1919).

STOUTAMIRE, W. P., 1958. Cytological variation in Texas gaillardias. Brittonia **10**(3):97-103.

TURNER, B. L., 1956. A cytotaxonomic study of the genus *Hymenopappus* (Compositae). Rhodora **58**:163-186, 208-242, 250-269, 295-308.

———, 1959. Meiotic chromosome counts for 12 species of Texas Compositae. Brittonia **11**:173-177.

———, 1962. Taxonomy of the genus *Hymenothrix* (Helenieae). Brittonia **14**:101-120.

———, 1963. Taxonomy of *Florestina* (Helenieae, Compositae). Brittonia **15**:27-46.

———, AND M. C. JOHNSTON, 1961. Chromosome numbers in the Compositae — III. Certain Mexican species. Brittonia **13**:64-69.

———, W. L. ELLISON, AND R. M. KING, 1961. Chromosome numbers in the Compositae — IV. North American species, with phyletic interpretations. Amer. Jour. Bot. **48**:216-223.

———, J. H. BEAMAN AND H. F. L. ROCK, 1961. Chromosome numbers in the Compositae — V. Mexican and Guatemalan species. Rhodora **63**:121-129.

WARNOCK, B. H., 1960. *Bahia woodhousei* in extreme western Texas. Wrightia **2**:74.

ERIGENIA, A GENUS NEW TO OKLAHOMA — While returning from the 1963 spring meeting of The Southwestern Assocation of Naturalists held in Pittsburg, Kansas, I stopped to study, and collect from, a northern part of Oklahoma Ozark Mountains along Lost Creek near Wyandotte. There I collected a plant which I had not seen before. I subsequently identified it as *Erigenia bulbosa* (Michx.) Nutt. The collection is *Wallis 8748*, wooded base of hill on Lost Creek, 1 mile east of Wyandotte, Ottawa County. The genus was not found during an earlier study of the region (Wallis, 1959) and has not been reported previosuly from the state (Waterfall, 1962). It is a genus of deciduous woods of northeastern United States and adjacent Canada, previously known to extend as far southwest as Missouri (Fernald, 1950) and Kansas (McGregor and Horr, 1953).

The same area, within 200 yards of the spot where *Erigenia bulbosa* was collected, has provided three other addi-

tions to the Oklahoma Flora: *Iris virginica* var. *Shreveì; Urtica dioica;* and, the introduced *Allium vineale* var. *compactum* (Wallis, 1959).

The eastern relationship of the plants growing in this area may be seen from the following additional associated species.

The forest includes: *Quercus rubra* var. *borealis; Q. Muehlenbergii* forma *Alexanderi; Juglans nigra; Carya ovalis; Ostrya virginana* var. *lasia; Acer rubrum; Tilia neglecta; Diospyros virginiana; Cornus florida; Asimina triloba;* and *Lindera Benzoin.*

Herbaceous species include: *Arisaema atrorubens* forma *zebrinum; Arisaema Dracontium; Polygonatum canaliculatum; Smilacina racemosa; Trillium viride; Urtica chamaedryoides; Asarum canadense; Anemonella thalictroides; Delphinium tricorne; Sanguinaria canadensis* var. *rotundifolia; Dentaria laciniata; Hybanthus concolor; Viola pensylvanica* var. *pensylvanica; Osmorhiza longistylis* var. *villicaulis; Phlox divaricata* var. *Laphamii;* and *Hydrophyllum virginianum.*

Specimens of the plants discussed above are deposited in the Herbarium of Oklahoma State University. Duplicates of the majority of them are in the author's private herbarium.

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LITERATURE CITED

FERNALD, M. L. 1950. Gray's manual of botany, Ed. 8, New York: American Book Company.

MCGREGOR, R. L. AND W. H. HORR. 1953. Kansas plants new to Kansas herbaria, VIII. Trans. Kans. Acad. Sci. **55**: 201.

WALLIS, C. S. 1959. Vascular plants of the Oklahoma Ozarks, Ph.D. thesis. Okla. State. Univ. Library, Stillwater.

WATERFALL, U. T. 1962. Keys to the flora of Oklahoma. The Research Foundation, Okla. State Univ., Stillwater.

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Vol. 66 October-December, 1964 No. 768

CONTENTS:

Sanchezia and Related American Acanthaceae
Emery C. Leonard and Lyman B. Smith 313

Species Crosses in Helianthus: II. Polyploid Species
C. B. Heiser and D. M. Smith 344

Genetic Barriers in the Cosmanthus Phacelias (Hydrophyllaceae) *George W. Gillett* 359

Chromosome Counts for Paspalum *Donald J. Banks* 368

Some Observations on the Dissemination of Tripsacum
Walton C. Galinat and Frank C. Craighead 371

Floristic Changes within Pitcher Plant Habitats in Georgia
Thomas Pullen, Jr., and Gayther L. Plummer 375

(Continued on Inside Cover)

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CONTENTS: — *continued*

Taxonomy of The Narrow-leaved Vernonia of the Southwestern United States *Samuel B. Jones, Jr.* .. 382

Gentiana austromontana, A New Species from the Southern Appalachians *James S. Pringle and Aaron J. Sharp* 402

Solidago rupestris and S. canadensis *J. R. Beaudry* 404

Linum modestum, A New Species from Mexico *C. Marvin Rogers* 406

Potentilla Robbinsiana in the White Mountains of New Hampshire *Frederic L. Steele* 408

A Flora of Northern New Hampshire (Review) *Frederic L. Steele* 411

Additions to the Flora of the Wolf Islands, New Brunswick for 1964 *A. R. Hodgdon and Radcliffe B. Pike* 413

Index to Volume 66 417

Rhodora

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SANCHEZIA AND RELATED AMERICAN ACANTHACEAE

EMERY C. LEONARD AND LYMAN B. SMITH

At the time of his retirement, the senior author was engaged in writing treatments of the Acanthaceae for several different floras and had discovered a number of new species in the process. Now that he is unable to continue his research as planned, it is desirable to finish and place on record as much of his work as possible. The junior author does not profess to be a specialist on Acanthaceae, but hopes to earn his title to the paper by verification and by additions to the original manuscript in data and illustrations.

The present paper is concerned principally with discoveries made in the preparation of the first part of the Acanthaceae for the "Flora of Peru" and is composed largely of novelties in *Sanchezia*. The original plan was to show the relationship of the new species by a key to all the Peruvian ones, but such a large proportion was covered in this way that it was decided to expand a little and write a synopsis of the whole genus.

Sanchezia Ruiz & Pavón

Fl. Peruv. Chil. Prodr. 5, *pl. 32*. 1794; Fl. Peruv. Chil. **1**: 7, *pl. 8, fig. b, c*. 1798.

Ancylogyne Nees *in* Mart. Fl. Bras. **9**: 63, *pl. 7*. 1847.

Steirosanchezia Lindau, Bull. Herb. Boiss. II. **4**: 316. 1904.

Erect or climbing herbs or shrubs, stems usually glabrous; flowers solitary or more often fascicled, usually large and conspicuous, yellow, orange, red, or purple, borne in heads, spikes, or racemes, the flower clusters subtended by small or large, rarely partly connate bracts,

these sometimes colored; calyx 5-parted; corolla tube subcylindric, the limb 5-lobed, the lobes equal; stamens 2, usually exserted; anthers normally 2-celled, longitudinally ciliate, mucronulate at base; staminodes 2; capsule oblong, 6-8-seeded; seeds orbicular.

1. Bracts at least 1 cm. wide, mostly 2-4.5 cm. long, ovate to oblong.
   2. Inflorescence capitate; leaves repand-crenate. Peru.
      3. Bracts ovate or lanceolate; leaves acuminate; corolla pink, pubescent ..... 1. *S. leucerythra.*
      3. Bracts oblong; leaves acute; corolla red ..... 2. *S. capitata.*
   2. Inflorescence spicate or paniculate.
      4. Bracts connate at least to the middle; corolla glabrous, yellow.
         5. Leaf blades with lateral nerves 15-17 to a side; corolla lobes 5 mm. long. Peru ..... 3. *S. cyathibractea.*
         5. Leaf blades with lateral nerves 9-12 to a side; corolla lobes 3 mm. long. Panama, Venezuela, Colombia, Peru .... 4. *S. pennellii.*
      4. Bracts free.
         6. Leaf blades pubescent, at least beneath.
            7. Stem and rachis densely vestite.
               8. Calyx segments oblong-lanceolate, long-acuminate. Peru. ..... 5. *S. dasia.*
               8. Calyx segments subligulate, broadly acute or rounded. Colombia ..... 6. *S. thinophila.*
            7. Stem and rachis glabrous or minutely hirtellous at the nodes alone. Peru.
               9. Corolla yellow; blades distinctly petiolate .... 7. *S. ovata.*
               9. Corolla crimson with yellow tip; blades subsessile, decurrent the whole length of the petiole .... 8. *S. bicolor.*
         6. Leaf blades wholly glabrous.
            10. Leaf blades rounded or subtruncate at base; petiole naked; corolla yellow.
               11. Bracts to 4 cm. long; leaf blades rounded at base, entire or undulate. Peru ..... 9. *S. stenantha.*
               11. Bracts scarcely more than 2 cm. long; leaf blades subtruncate at base, coarsely and prominently dentate. Ecuador. ..... 10. *S. coleifolia.*
            10. Leaf blades narrowed at base.
               12. Petioles all winged.
                  13. Corolla pubescent.
                     14. Corolla red or rose-lilac.
                        15. Bracts all triangular-cuspidate; basal fascicles of flowers pedunculate. Bolivia. (Specimens of *Suessenguthia trochilophila* with incomplete flowers may be sought here).
                  15. Bracts of all but the lowest fascicles of flowers broadly rounded; fascicles all sessile in elongate spikes. Peru. ..... 11. *S. megalia.*

14. Corolla yellow.
    16. Bracts hirsute. Peru ..... 12. *S. oblonga.*
    16. Bracts glabrous or slightly vestite at base.
        17. Corolla tube finely and laxly appressed-pubescent outside; leaf blades subentire to shallowly undulate-dentate. Peru ..... 13. *S. peruviana.*
        17. Corolla tube densely and conspicuously white-sericeous outside.
            18. Leaf blades oblong-obovate, coarsely undulate-dentate, the lateral nerves 15-20 to a side. Ecuador. ..... 14. *S. sericea.*
            18. Leaf blades lanceolate, obscurely undulate, the lateral nerves 14-15 to a side. Colombia. .....6. *S. thinophila.*

13. Corolla glabrous, yellow.
    19. Staminodes ca. 5 mm. long; leaf blades broadest near the apex. Ecuador. ..... 15. *S. nobilis.*
    19. Staminodes 20-25 mm. long; leaf blades mostly broadest near the middle.
        20. Calyx segments 15-18 mm. long. From cultivation (Peru or Ecuador?) ..... 16. *S. speciosa.*
        20. Calyx segments 20-25 mm. long. Peru. .... 17. *S. flava.*

12. Petioles naked when fully developed.
    21. Corolla red or orange-red.
        22. Leaf blades obovate, to 16 cm. wide, coarsely crenate-dentate; lowest bracts subfoliaceous; calyx segments 14 mm. long; subligneous herb to 1.3 m. high; staminodes 3-4 mm. long. Peru. .... 18. *S. pulchra.*
        22. Leaf blades elliptic, narrower, entire or subentire.
            23. Bracts ample, covering most or all of the calyces at anthesis. Brazil. ..... 19. *S. munita.*
            23. Bracts narrower, exposing most of the calyces at anthesis. Peru.
                24. Upper bracts rounded ..... 20. *S. rubriflora.*
                24. Upper bracts acute ..... 37. *S. rosea.*

21. Corolla yellow.
    25. Corolla tube definitely vestite outside toward the apex; bracts uniformly suborbicular with broadly rounded apices. Ecuador. ..... 21. *S. helophila.*
    25. Corolla tube glabrous. Peru.
        26. Calyx segments cuneate, subtruncate, subequal; leaf blades elliptic, to 14.5 cm. wide .... 22. *S. xantha.*
        26. Calyx segments oblong or oblanceolate, obtuse; leaf blades oblong-elliptic, 7-8 cm. wide.

27. Upper bracts 4 cm. long, covering the calyces at anthesis. ..... 23. *S. habra.*
27. Upper bracts 2 cm. long, exposing most of the calyces at anthesis ..... 24. *S. killipii.*

1. Bracts less than 10 mm. wide, linear to ovate.
29. Bracteoles (as well as bracts and calyx segments) ending in long filiform tips, linear-lanceolate, densely pilose; petioles naked. Peru.
30. Leaf blades rounded at base.
31. Lower surface of leaf blades glabrous except the hirsute costa and veins; spikes 5-7 cm. long with fascicles densely imbricate and indistinguishable ..... 25. *S. sanmartinensis.*
31. Lower surface of leaf blades evenly villous; spikes ca. 17 cm. long, the fascicles distinct ..... 26. *S. villosa.*
30. Leaf blades narrowed at base.
32. Stems curved; plants scandent; corollas orange ..... 27. *S. aurea.*
32. Stems straight; shrubs; corollas not orange.
33. Corollas garnet and yellow; bracts to 9 cm. long. ..... 28. *S. stenomacra.*
33. Corollas unicolorous; bracts to 7 cm. long. (Specimens of *Trichosanchezia* with incomplete flowers may be sought here, but are distinguishable by bracts not over 4 cm. long and yellow corollas).
34. Corollas purple; leaf blades only about twice as long as wide; inflorescence shorter than the leaves. ..... 29. *S. filamentosa.*
34. Corollas rose; leaf blades at least three times as long as wide; inflorescence pedunculate, exceeding the leaves. ..... 30. *S. rhodochroa.*

29. Bracteoles rounded to acuminate but not filamentous-tipped, if finely acuminate *(S. klugii)* then not densely pilose.
35. Calyx segments acuminate.
36. Corolla pubescent. Peru.
37. Hairs of the corolla 0.5 mm. long or less.
38. Stamens exserted; hairs of the corolla slender.
39. Flowers fascicled at each node of the spike; corolla orange. ..... 31. *S. aurantiaca.*
39. Flowers solitary at each node of the spike; corolla red or rose ..... 32. *S. klugii.*
38. Stamens included; hairs of the corolla subconical with enlarged bases; corolla probably red .. 33. *S. williamsii.*
37. Hairs of the corolla 0.5-2 mm. long.
40. Bracts 12-15 mm. long, 6-8 mm. wide; larger leaves over 3 times as long as broad ..... 34. *S. coccinea.*
40. Bracts 7-8 mm. long, 2.5-4 mm. wide, sometimes decidu-

ous; larger leaves 2.5 to less than 2 times as long as broad.

41. Stamens included, the filaments shorter than the corolla tube; leaves caudate-acuminate; inflorescence lax. ..... 35. *S. punicea.*

41. Stamens exserted or the filaments longer than the corolla tube but curved inside it; leaves short-acuminate; inflorescence dense .... 36. *S. woytkowskii.*

36. Corolla glabrous.

42. Bracts to 25 mm. long and 6-11 mm. wide; spikes lax. Peru. ..... 37. *S. rosea.*

42. Bracts not more than 15 mm. long and 5 mm. wide.

43. Spikes 1-3, lax; leaf blades to 4.5 cm. wide. Peru. ..... 38. *S. sprucei.*

43. Spikes 4 or more, dense; leaf blades to 11 cm. wide.

44. Flowers 2 at each node, not secund. Ecuador. ..... 39. *S. lampra.*

44. Flowers 1 at each node and always on the same side of the rachis, thus secund.

45. Corolla purple. Ecuador. ..... 40. *S. longiflora.*

45. Corolla carmine. Peru. ..... 41. *S. oxysepala.*

35. Calyx segments acute or obtuse, often apiculate.

46. Flowers on slender pedicels up to 1 cm. long. Peru. ..... 42. *S. pedicellata.*

46. Flowers sessile or subsessile.

47. Inflorescence compact, ovoid. Peru. ..... 43. *S. conferta.*

47. Inflorescence open or simple.

48. Bracts densely tomentose, to 10 mm. long. Peru. ..... 44. *S. lasia.*

48. Bracts glabrous, ciliolate, or minutely puberulent.

49. Leaf blades broadly ovate, subtruncate at base; calyx 25 mm. long; corolla yellow. Ecuador. ..... 10. *S. coleifolia.*

49. Leaf blades elliptic or lanceolate, regularly attenuate at base.

50. Flowers all solitary; bracts 3-8 mm. long. Peru.

51. Plants scandent; leaf blades to 5 cm. wide; corolla glabrous ..... 45. *S. scandens.*

51. Plants erect, herbs, shrubs, or small trees.

52. Leaf blades to 10 cm. wide, less than twice as long as wide ..... 46. *S. sylvestris.*

52. Leaf blades not over 4 cm. wide, more than 3 times as long as wide.

53. Bracts to 7 mm. long; flowers imbricate. ..... 47. *S. ferreyrae.*

53. Bracts not over 4 mm. long.

54. Calyx segments to 15 mm. long; flowers lax; tree 4 m. high ..... 48. *S. arborea.*
54. Calyx segments 12 mm. long; flowers imbricate; shrub 2 m. high .. 49. *S. decora.*

50. Flowers 2 or more at each node, rarely a single flower at some nodes.
55. Largest calyx segments 12-13 mm. long.
56. Corolla glabrous. Peru. ..... 50. *S. lispa.*
56. Corolla pubescent toward apex. Colombia. ..... 51. *S. putumayensis.*
55. Largest calyx segments 15-22 mm. long.
57. Corolla red or if unknown *(S. tigrina)* then the largest calyx segments not over 17 mm. long and the bracts minutely puberulent.
58. Bracts minutely puberulent and ciliolate; calyx segments 15-17 mm. long. Peru. ..... 52. *S. tigrina.*

58. Bracts glabrous.
59. Stamens included; corolla 3 cm. long. Ecuador. ..... 53. *S. parviflora.*
59. Stamens exserted; corolla 4 cm. long.
60. Calyx segments acute; flowers 2 at each node. Colombia. ..... 54. *S. lutea.*
60. Calyx segments rounded; flowers (1-) 2-6 at each node.
61. Bracts ovate, 15-16 mm. long; flowers 4-6 at each node. Peru. ..... 55. *S. loranthifolia.*
61. Bracts linear, 8 mm. long; flowers (1-) 2-4 at each node. Ecuador. .... 56. *S. skutchii.*

57. Corolla yellow; largest calyx segments 20 mm. long.
62. Largest bracts 20 mm. long; corolla 4 cm. long. Peru. ..... 57. *S. tarapotensis.*
62. Largest bracts 10-16 mm. long.
63. Corolla 5-5.5 cm. long; stamens exserted 5 cm. Mexico, Central America, Colombia. ..... 58. *S. parvibracteata.*
63. Corolla 4.5 cm. long; stamens slightly exserted. Ecuador. .... 59. *S. ecuadorensis.*

1. **Sanchezia leucerythra,** sp. nov.

Frutex 2-3 m. altus, caulibus quadrangularibus, glabris, sulcatis; foliorum lamina lanceolata, usque ad 18 cm. longa et 5 cm. lata, acuminata, apice ipso obtuso, supra glabra, minute papillosa, cystolithis multis, 0.25 mm. longis, subtus in costa et venis lateralibus

pilosa, pilis appressis, firma, marginibus leviter repando-crenatis, costa et venis 16 conspicuis; petioli usque ad 2 cm. longi, appresso-pilosi; inflorescentia capitata, 3.5 cm. longa, 3 cm. lata; bracteae infimae lanceolatae, usque ad 4.5 cm. longae, 1.5 cm. latae, acuminatae, pilosae, pilis appressis, 0.5 mm. longis, brunneis, bracteae aliae ovatae, usque ad 3 cm. longae, 1.3 cm. latae, acuminatae, acutae, sericeae, pilis appressis, ca. 5 mm. longis, sursum roseae, basi albae, bracteolae 3 cm. longae, 1 cm. latae, acuminatae, sericeae, pilis appressis, 0.5 mm. longis, brunneis; calycis segmenta 27-30 mm. longa, subaequalia, 2-5 mm. lata, lineari-lanceolata, gracili-acuminata, sericea; corolla pallide rubra, basi alba, 4 cm. longa, basi 3 mm. lata, sursum 10 mm. lata, minute pubescentia, pilis recurvatis, lobis ca. 10 mm. longis, late rotundatis et leviter emarginatis, erectis, dense retrorseque pubescentibus; stamina (juvenilia?) inclusa, gilva; ovarium pilosum. (Name from the Greek, *leukerythros, pink*). Fig. 1, A, B.

PERU: JUNÍN: Dense forest near Perene Bridge, Río Paucartambo Valley, 700 m, June 19, 1929, *Killip & A. C. Smith 25271* (NY, type). Open place in forest, Río Negro, 800 m, August 14, 1960, *Woytkowski 5794* (US).

2. **Sanchezia capitata** (Nees) Lindau, Bull. Herb. Boiss. II, 4: 315. 1904.

Ancylogyne capitata Nees *in* DC. Prodr. 11: 222. 1847.
PERU: JUNÍN: Pangoa, *Mathews 1230* (K, type).

3. **Sanchezia cyathibractea** Mildbr. Notizbl. Bot. Gart. Berlin 9: 267. 1925.

PERU: AMAZONAS: Rainforest of Yarina Cocha on the Río Blanco, at the mouth of the Río Capanahua, 125 m, July 1923, *Tessmann 3134* (B, type). Same, alt. 155 m, October 2, 1925, *Tessmann 5423* (B, F photo 5888).

4. **Sanchezia pennellii** Leonard, Journ. Washington Acad. Sci. 16: 488. 1926.

PANAMA: DARIEN: *P. H. Allen 269* (MO, US); *4300* (MO, US). *H. Pittier 6527* (US). *R. S. Williams 659* (NY, US).
VENEZUELA: DELTA AMACURO: Rainforest, Curiapo, O m, December 1952, *Gines 4919* (US).
COLOMBIA: ANTIOQUIA: Sandy loam forest along the Magdalena River at Vuelta de Acuña, 125-130 m, January 14, 1918, *Pennell 3798* (US, type). General, cf. Leonard, Contrib. U. S. Nat. Herb. 31: 51. 1951.

PERU: LORETO: Dense forest, Yurimaguas, lower Río Huallaga, 135 m, August-September 1929, *Killip & A. C. Smith 27993* (F, NY, US). Clearing of dense forest, Santa Rosa, lower Río Huallaga, below Yurimaguas, 135 m, September 1929, *Killip & A. C. Smith 28829* (US).

5. **Sanchezia dasia,** sp. nov.

Frutex, caulibus tetragonis, sulcatis, pilosis, pilis usque ad 1.5 mm. longis, patulis, brunneis; foliorum lamina oblongo-elliptica, usque ad 28 cm. longa, 9 cm. lata, breviter acuminata, basi angustata, supra pilosa, cystolithis 0.25 mm. longis, multis, conspicuis, minute papillosa, subtus pilosa, pilis patulis vel ascendentibus, usque ad 2 mm. longis, plerumque in costa et venis (12-14) dispositis, firma, marginibus integris vel leviter crenatis; petioli 3 cm. longi, pilosi; spicae terminales, laxae, internodiis 3-4 cm. longis, dense pilosis, pilis 2.5 mm. longis, patulis, rachibus tetragonis, sulcatis; flores plures in fasciculis aggregati; bracteae lanceolatae, 3.5-6 cm. longae, 15-18 mm. latae, acutae, infima foliacea, aliae 5-nervatae, omnes pilosae; bracteolae lanceolatae, 32 mm. longae, 7 mm. latae, acutae, pilosae; calycis segmenta oblongo-lanceolata, 30-35 mm. longa, 2-4 mm. lata, gracili-acuminata, pilosa; corolla aurea, ca. 4 cm. longa, minute pubescens, pilis recurvis, lobis ovatis, ca. 4 mm. longis, 3 mm. latis, recurvatis; stamina inclusa; ovarium sparse minuteque pubescens. (Name from the Greek, *dasya, hairy*). Fig. 1, C, D.

PERU: HUANUCO: Tropical woods at La Merced, between Situlli and Santa Cruz, 500-600 m, August 3, 1948, *Ferreyra 4391* (US, type).

6. **Sanchezia thinophila** Leonard, Bot. Mus. Leafl. Harvard Univ. **16:** 94, *pl. 16.* 1953.

6a. Forma **thinophila.**

COLOMBIA: AMAZONAS: Along Río Loretoyacu, Trapecio Amazónico, 100 m, October 20-30, 1945, *R. E. Schultes 6607* (US, type).

6b. Forma **glabra** Leonard, Contrib. U. S. Nat. Herb. **31:** 680. 1958.

COLOMBIA: AMAZONAS: Along Río Loretoyacu, Trapecio Amazónico, 100 m, November 1945, *R. E. Schultes 6937* (US, type).

7. **Sanchezia ovata** R. & P. Fl. Peruv. Chil. **1:** 7, *pl. 8, fig. c.* 1798. *Sanchezia glabra* Pers. Syn. **1:** 24. 1805.

PERU: HUÁNUCO: Reported from Cuchero, Pozuzo, and Pillao, by *Ruiz* and *Pavón.*

8. **Sanchezia bicolor,** sp. nov.

Frutex, caulibus quadrangularibus, glabris vel in nodis minute hirtellis; foliorum lamina asymmetrica, oblongo-elliptica vel oblongo-ovata, usque ad 30 cm. longa et 13 cm. lata, breviter acuminata, basi in petiolum decurrens, leviter crenata, supra glabra, minute papillosa, costa et venis prominentibus, subtus mediocriter hirtella, cystolithis obscuris; petioli usque ad 1 mm longi, dense hirtelli; spicae terminales, glabrae; bracteae lanceolatae vel ovatae, 3-4 cm. longae, 2 cm. latae, acutae; bracteolae bracteis similes sed minores; calycis segmenta (immatura) glabra, lanceolata, apice rotundata, 15-18 mm. longa, 1.5-4 mm. lata; corolla coccinea, apice lutea, sursum puberulenta.

PERU: SAN MARTÍN: Abandoned rock tunnel at Boquerón Pass,

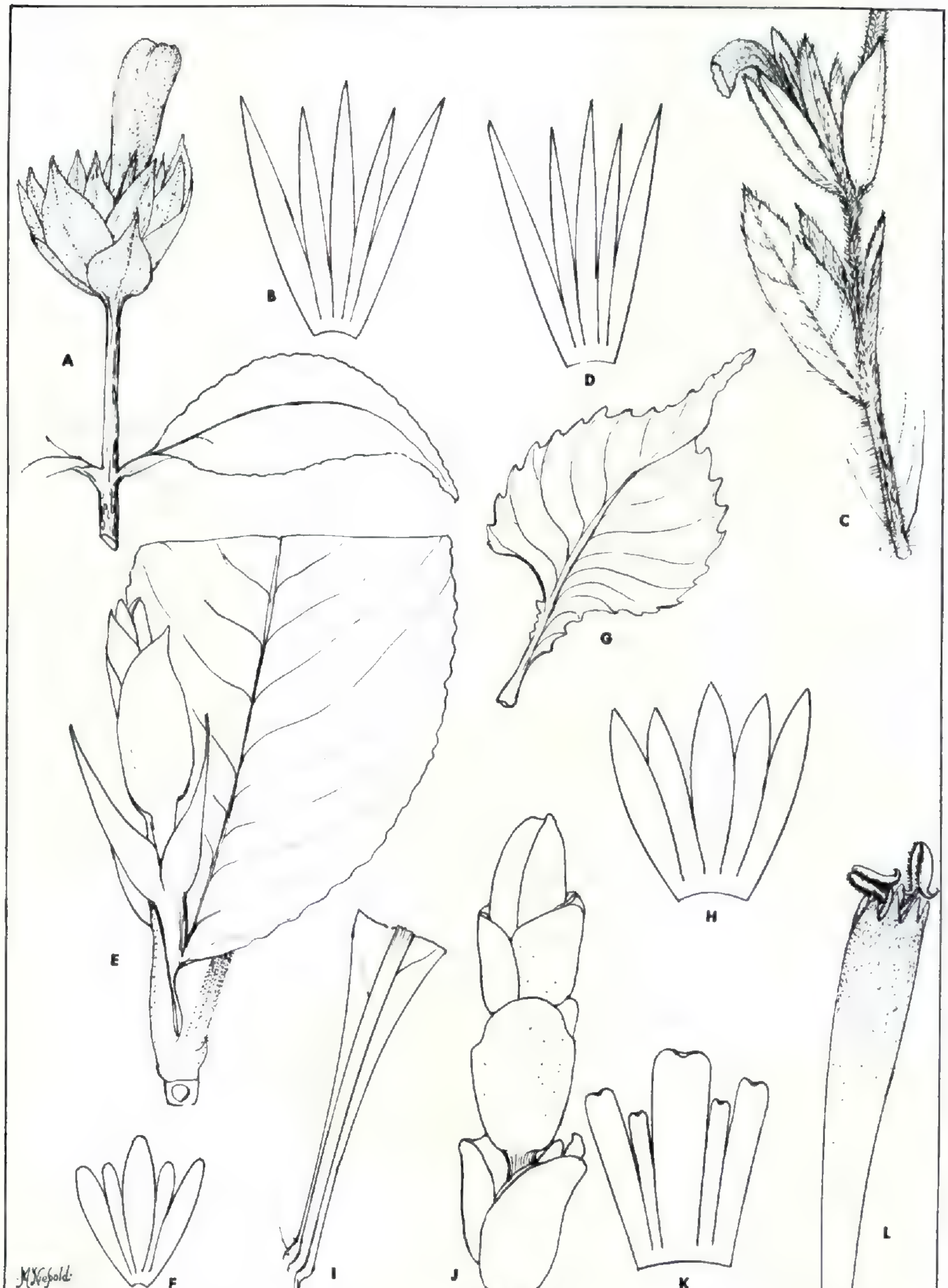

Figure (1)

A: *Sanchezia leucerythra*, inflorescence × ½; B: calyx × 1; C: *S. dasia*, base of inflorescence × ½; D: calyx × 1; E: *S. bicolor*, inflorescence × ½; F: calyx × 1; G: *S. coleifolia*, leaf × ½; H: calyx × 1; I: *S. megalia*, base of leaf × ½; J: inflorescence × ½; K: calyx × 1; L: corolla × 1.

between Tingo María and Pucallpa, 410 m, December 16, 1949, *Allard 21711* (US, type). Fig. 1, E, F.

9. **Sanchezia stenantha** Leonard, Journ. Washington Acad. Sci. **16:** 489. 1926.

PERU: HUÁNUCO: At Cuchero, Pozuzo, or Pillao, *Ruiz & Pavon* (BM, NY photo 757; M, F photo 29190). In dense green woods at Cayumba, Prov. Huánuco, 800-900 m, July 15, 1948, *Ferreyra 4211* (US). Tropical woods at La Merced, Prov. Pachitea, 500-600 m, August 3, 1948, *Ferreyra 5156* (US). In stream at Pozuzo, 650 m, January 1923, *Macbride 4634* (F, type, NY photo; US). Forest at Tingo Maria, *Asplund 12086* (S). JUNÍN: Meriatiriani, 500 m, June-July 1929, *Killip & A. C. Smith 26207* (NY, US). Dense forest at Perene Bridge, on the Río Paucartambo, 700 m, June 19, 1929, *Killip & A. C. Smith 25287* (NY, US). Dense forest at Yapas, 1350-1600 m, June 28, 1929, *Killip & A. C. Smith 25472* (NY, US). Lima: Jardín Botánico, Lima, *Velarde 4816* (US).

10. **Sanchezia coleifolia,** sp. nov.

Herba 1.5 m. alta, caulibus quadrangularibus, leviter sulcatis, glabris; foliorum lamina late ovata, ad 9 cm. longa et 7 cm. lata, basi late subtruncata dein paulo decurrens, apice caudato-acuminata, firma, marginibus grosse dentata, costa et venis lateralibus 8-10 paribus subtus prominentibus, utrinque glabra, cystolithis densis, 0.2-0.6 mm. longis; petioli ca. 1 cm. longi, nudi; inflorescentia terminalis, pauciramosa, floribus paucis in fasciculis congestis, fasciculis secundis; bracteae late ovatae, ad 22 mm. longae, 8-12 mm. latae, triangulari-acutae, glabrae, aurantiacae, cystolithis multis, parallelis; bracteolae oblongo-ovatae, 10-12 mm. longae, apice late rotundatae et pubescentes; calycis segmenta oblonga, late acuta, longitudine subaequalia, 25 mm. longa, segmentum posterius 5 mm. latum, segmenta anteriora 5-6 mm. lata, segmenta lateralia 3 mm. lata, omnia apice pubescentes; corolla flava (! Steyermark), corolla staminibusque non visis. Fig. 1, G, H.

ECUADOR: ORO: Cultivated, between Río Minas Nuevas northwest to above Paccha, 2135-2740 m, August 25, 1943, *Steyermark 54127* (US, type).

11. **Sanchezia megalia,** sp. nov.

Frutex, 2-3 m. altus, glaber, caulibus quadrangularibus, leviter sulcatis; foliorum lamina oblongo-ovata, usque ad 40 cm. longa et 15.5 cm. lata, breviter acuminata, basi angustata, in petiolum decurrens, firma, crenato-dentata, costa et venis lateralibus circa 12 prominentibus, cystolithis 0.25-0.5 mm. longis, obscuris; petioli 2-3 cm. longi, canaliculati; spicae terminales et interdum basi spica parva secundaria, floribus in fasciculis congestis; bracteae infimae foliaceae, lanceolatae, 4-6 cm. longae, ca. 2 cm. latae, acuminatae, bracteae

aliae ovatae, 3.5 cm. longae, 3 cm. latae, obtusae vel rotundatae, cystolithis pluribus, parallelis; bracteolae obovatae, 2.5 cm. longae, 1 cm. latae, apice rotundatae, leviter emarginatae; calycis segmenta inaequalia, segmentum posterius oblanceolatum, 30 mm. longum, 7 mm. latum, segmenta anteriora 25 mm. longa, 3 mm. lata, linearia, segmenta lateralia linearia, 20 mm. longa, 1.5-2 mm. lata, omnia emarginata, venosa, marginibus subhyalinis; corolla ignea, tubo 45 mm. longo, basi 4 mm. lato, sursum 10 mm. lato, deorsum glabro, sursum minute pubescens, pilis ca. 0.25 mm. longis, retrorsis, lobis ovatis, 6 mm. longis, ca. 4 mm. latis, obtusis; stamina vix exserta, filamentis pilosis, antheris 6 mm. longis, ventre minute hirsuta, basi calcarata; staminodia ca. 3 cm. longa. (From the Greek, *megaleios, magnificent*). Fig. 1, I, J, K, L.

PERU: JUNÍN: Wooded valley at La Merced, 700 m, May 29-June 4, 1929, *Killip & A. C. Smith 24080* (US, type; F, NY).

12. **Sanchezia oblonga** R. & P. Fl. Peruv. Chil. **1:** 7, *pl. 8, fig. b.* 1798.

Sanchezia hirsuta Pers. Syn. Pl. 1: 24. 1805.

PERU: HUÁNUCO: Reported from Cuchero, Pozuzo, and Pillao, by *Ruiz* and *Pavón.*

13. **Sanchezia peruviana** (Nees) Rusby, Mem. Torrey Bot. Club **6:** 103. 1896.

Ancylogyne peruviana Nees *in* DC. Prodr. **11:** 222. 1847.

Sanchezia macbridei Leonard, Journ. Washington Acad. Sci. **16:** 487. 1926.

PERU: AYACUCHO: Densely forested valley at Cacarrapa, 1500 m, May 1929, *Killip & A. C. Smith 23205* (NY, US). Dense forest near Kimpitiriki, 400 m, May 10, 1929, *Killip & A. C. Smith 22954* (F, NY, US). CUZCO: Encuentro, Convención, January 1938, *Soukup 819* (F). Along stream, Machu Picchu, 2000 m, February 3, 1939, *Stork, Horton & Vargas 10492* (F); *Vargas 2131* (F). Potrero, 1250 m, March 2, 1943, *Vargas 3240* (GH). HUANUCO: Sunny mountain at Pampayacu, 1200 m, July 1923, *Macbride 5056* (F, type of *Sanchezia macbridei* Leonard; US). Cueva de las Pavas, February 25, 1947, *Ferreyra 1612* (GH). Green woods at Cayumba, between Huánuco and Tingo Maria, 800-900 m, July 15, 1948, *Ferreyra 4220* (US). Forest at Tingo Maria, *Asplund 12081* (S); February 1944, *Soukup 2282* (F). Forest west of Divisoria, *Asplund 12587* (S). JUNÍN: Pangoa, *Mathews 1221* (K, Herb. Hooker). Casapi, *Mathews 2013* (K, Herb. Hooker, lectotype, also Herb. Bentham). Sesuya, Chachapoyas, *Mathews 3168* (K, Herb. Hooker, *not* 3108 as printed in DC. Prodr.). Thickets at La Merced, 700 m, May - June 1929, *Killip & A. C. Smith 23411* (F, NY, US). Chanchanmayo Valley, 1500 m, August 1930, *Schunke 1758* (F). Villarica, August 1955, *Soukup 4376* (US, immature). Montaña, San Luis de Shuaro, Ahanchamayo, 750 m, June 5, 1959, *Diers 1227* (Köln). LORETO: Vicinity of Iquitos, on the Río Itaya, *Melin 349*

(S). Pebas on the Amazon River, July 1929, *L. Williams 1906* (F). Soledad on Río Itaya, 100 m, September 1929, *Killip & A. C. Smith 29549* (F, NY, US). Forest at Mishuyacu near Iquitos, 100 m, December 1929, *Klug 667* (F, NY, US). SAN MARTIN: Forest, San Roque, *Melin 368* (S); *L. Williams 6933* (F, US). Zepelacio, 1200-1600 m, January 1934, *Klug 3478* (AAH, F, GH, NY, US). Tingo Maria, *Allard 21883* (US). Divisoria, between Tingo Maria and Pucallpa, 1600 m, November 1949 - January 1950, *Allard 22183* (US); *Ferreyra 1664* (US). Along the Río Huallaga near Tingo Maria, *Allard 22432* (US).

BOLIVIA: LA PAZ: Mapiri, July - August 1892, *Bang 1473* (GH, US).

Mr. N. Y. Sandwith has kindly supplied us with sketches and detailed information on the Mathews collections at Kew and we are happy to follow this suggestion from his letter: "The best of the three syntypes, from the point of view of inflorescence and corollas, is undoubtedly no. 2013 (Casapi) in Herb. Hook., and this has the advantage of being duplicated in Herb. Benth. You would be well advised to select it as the lectotype."

14. **Sanchezia sericea** Leonard, Journ. Washington Acad. Sci. **16:** 486. 1926.

ECUADOR: TUNGURAHUA: Moist banks of the Pastaza River between Baños and Cashurco, 1300-1800 m, September 25, 1923, *Hitchcock 21801* (US, type).

15. **Sanchezia nobilis** Hook. Bot. Mag. **92:** pl. 5594. 1866.
? *Sanchezia glaucophylla* Hort. Gard. Chron. 587. 1869.

ECUADOR: PEARCE (K, type).

16. **Sanchezia speciosa** Leonard, Journ. Washington Acad. Sci. **16:** 490. 1926.

CUBA: Cultivated, Botanical Garden of Havana, January 1905, *A. H. Curtiss 622* (US, type). Same, March 14, 1906, *Van Hermann 2700* (US).

HAITI: Cultivated, Massif de la Selle, Pétionville, October 19, 1924, *Ekman H-2204* (US).

DOMINICAN REPUBLIC: Cultivated, Santiago City, August 25, 1955, *Jiménez 3049* (US).

MARTINIQUE: *Duss 835* (NY).

GRENADA: Wayside, Belvedere, October 5, 1945, *P. Beard 1274* (US). Moist region at Good Hope, September 30, 1949, *Vélez 3230* (US).

17. **Sanchezia flava** Leonard, Journ. Washington Acad. Sci. **22:** 134. 1932.

PERU: JUNÍN: Dense forest, Schunke Hacienda, above San Ramón, 1400-1700 m, June 8, 1929, *Killip & A. C. Smith 21640* (US, type; F, NY).

18. **Sanchezia pulchra** Leonard, Journ. Washington Acad. Sci. **22:** 135. 1932.

PERU: JUNÍN: Dense forest, Puerto Bermudez, 375 m, July 1929, *Killip & A. C. Smith 26447* (NY, US). LORETO: Dense forest, Puerto Arturo, lower Río Huallaga below Yurimaguas, 135 m, August 24, 1929, *Killip & A. C. Smith 27842* (US, type; F, NY). Edge of forest, Hacienda Soledad, Río Itaya, *Asplund 14448* (S). DEPARTMENT (?): *Rodriguez* (F).

19. **Sanchezia munita** (Nees) Planch. Fl. des Serres **23:** 257. 1880.

Ancylogyne munita Nees *in* Mart. Fl. Bras. **9:** 63, *pl. 7.* 1847.

BRAZIL: AMAZONAS: Woods along Rio Madeira, *Martius s. n.* (M, type; F photo 20539). PARÁ: Swampy jungle, Breves, Amazon estuary, October 23, 1929, *Killip & A. C. Smith 30208* (US).

20. **Sanchezia rubriflora** Leonard, Journ. Washington Acad. Sci. **22:** 135. 1932.

PERU: LORETO: In deep jungle, Río Nanay, *L. Williams 380* (F). La Victoria on the Amazon River, August-September 1929, *L. Williams 2880* (F, US). Forest at Puerto Arturo, lower Río Huallaga, 155-210 m, October-November 1929, *L. Williams 5143* (F, US). HUÁNUCO: Pozuzo, June 1923, *Macbride 4665* (F). JUNÍN: Dense forest at Cahuapanas, on the Río Pichis, 340 m, July 20, 1929, *Killip & A. C. Smith 26768* (US, type; NY).

21. **Sanchezia helophila,** sp. nov.

Frutex 2 m. altus, caulibus quadrangularibus, glabris, sulcatis, angulis rotundatis; foliorum lamina elliptica vel obovata, usque ad 23 cm. longa et 9.5 cm. lata, acuminata, basi acuta, firma, grosse crenato-dentata, utrinque glabra, supra minute papillosa, costa et venis lateralibus 12 paribus prominentibus, cystolithis 0.2-0.3 mm. longis; petioli adulti nudi, usque ad 6 cm. longi, glabri, canaliculati; inflorescentiae terminales, 3-ramosae, floribus pluribus in fasciculis subglobosis congestis, spicarum pedunculis 7-9 cm. longis, internodiis 2.5-3.5 cm. longis, minutissime obscureque albido-pubescentibus, sulcatis; bracteae liberae, suborbiculares, 3 cm. longae, late rotundatae, rubrae, glabrae, cystolithis pluribus, parallelis; bracteolae obovatae, bracteas subaequantes, apice minutissime pubescentes; calycis segmenta anguste spathulata, subaequalia, ca. 24 mm. longa, rotundata, segmentum posterius 5 mm. latum, alia angustiora; corolla aurea, 4.5 cm. longa, sursum 7 mm. lata, minute pubescentia, pilis recurvatis, lobis late ovatis, 3 mm. longis, emarginatis; stamina 15 mm. exserta. (From the Greek, *helos, marsh,* and *philos, loving*). Fig. 2, A, B.

ECUADOR: NAPO-PASTAZA: In marsh, vicinity of Puyo, eastern foot-hills of the Andes, 750-1000 m, September 1939, *Skutch 4498* (US, type).

Figure (2)

A: *Sanchezia helophila*, inflorescence × ½; B: calyx segment × 1; C: *S. xantha*, base of leaf × ½; D: flower × 1; E: calyx segment × 1; F: *S. habra*, inflorescence × ½; G: flower × 1; H: *S. sanmartinensis*, inflorescence × ½; I: calyx segment × 1.

22. **Sanchezia xantha,** sp. nov.

Herba (! Ferreyra), caulibus quadrangularibus, glabris, sulcatis, angulis rotundatis; foliorum lamina elliptica, usque ad 30 cm. longa et 14.5 cm. lata, breviter acuminata (apice ipso acuto), basi acuta, firma, integra vel leviter crenata, utrinque glabra, supra minute papillosa, costa et venis lateralibus 15 paribus prominentibus, cystolithis 0.25-0.5 mm. longis, obscuris; petioli adulti nudi, usque ad 4 cm. longi, glabri, canaliculati; spicae terminales, glabrae, pedunculis 7 cm. longis, internodiis 1-2 cm. longis, glabris, sulcatis; bracteae ovatae, 2 cm. longae, ca. 15 mm. latae, acutae, rubrae; bracteolae bracteis similes sed minores; calycis segmenta longitudine subaequalia, 15-20 mm. longa, subtruncato-rotundata, segmentum posterius cuneatum, apice 9 mm. latum, segmenta anteriora anguste cuneata, apice fere 5 mm. lata, segmenta lateralia anguste cuneata, apice fere 3 mm. lata; corolla 4.5 cm. longa, basi 3 mm. lata, sursum 7 mm. lata, glabra, lutea, lobis ca. 3 mm. longis et latis, rotundatis, recurvatis; stamina 1 cm. exserta, antheris 5 mm. longis, ventre minute hirsutis, basi calcaratis. (From the Greek, *xanthos, yellow*). Fig. 2, C, D, E.

PERU: Loreto: High evergreen forest, below Divisoria, near Sinchono, Prov. Coronel Portillo, 1200-1300 m, July 21, 1948, *Ferreyra 4275* (US, type).

23. **Sanchezia habra,** sp. nov.

Frutex 2 m. altus, caulibus quadrangularibus, glabris, sulcatis, angulis rotundatis; foliorum lamina oblongo-elliptica vel obovata, usque ad 27 cm. longa, 8 cm. latae, apice breviter acuminata, aliquando curvata, basi acuta, utrinque glabra, costa et venis lateralibus 9-12 paribus prominentibus, cystolithis multis, 0.25-0.5 mm. longis, obscuris; petioli adulti nudi, usque ad 3 cm. longi, glabri, canaliculati; inflorescentiae tripartitae, floribus pluribus in fasciculis congestis; bracteae infimae ovatae, usque ad 6 cm. longae, 4 cm. latae, triangulari-acutae, bracteae aliae minores, 3.5-4 cm. longae, 2 cm. latae, acutae, omnes glabrae, cystolithis pluribus, parallelis; bracteolae oblongo-lanceolatae, 2-2.5 cm. longae, 3-5 mm. latae, acutae, glabrae; calycis segmenta oblanceolata, inaequalia, 15-18 mm. longa, 2-3 mm. lata, obtusa, glabra; corolla aurea, glabra, 4.5 cm. longa, basi 4 mm. lata, sursum 8 mm. lata, fauce leviter constricta, lobis ca. 4 mm. longis, 3 mm. latis, rotundatis, revolutis; filamenta ad 10 mm. exserta, pilosa, pilis ca. 1 mm. longis; antherae 5 mm. longae, ventre minute hirsutae, basi calcaratae. (Name from the Greek, *habros, graceful*). Fig. 2, F, G.

PERU: San Martin: Forest, Pongo de Cainarachi, Río Cainarachi, 230 m, September - October 1932, *Klug 2671* (US, type; F, GH, NY).

24. **Sanchezia killipii** Leonard, Journ. Washington Acad. Sci. 22: 137. 1932.

PERU: Loreto: Dense forest, Santa Rosa, lower Río Huallaga

below Yurimaguas, 135 m, September 4, 1929, *Killip & A. C. Smith 28967* (US, type; NY).

25. **Sanchezia sanmartinensis**, sp. nov.

Frutex, caulibus quadrangularibus, sulcatis, angulis rotundatis, hirsutis, pilis usque ad 1.5 mm. longis, patulis vel ascendentibus, brunneis; foliorum lamina ovata vel oblongo-ovata, apice breviter acuminata, apice ipso obtuso, basi rotundata vel leviter cordata, aliquando inaequaliter in petiolum annectens, usque ad 21 cm. longa et 14 cm. lata, firma, integra vel leviter crenata, supra glabra, cystolithis conspicuis, multis, 0.25-0.5 mm. longis, subtus glabra, costa et venis 8-10 paribus pilosis, pilis 1-1.5 mm. longis; petioli 1.5-5 cm. longi, pilosi, pilis 1-1.5 mm. longis, appressis vel ascendentibus, canaliculati; inflorescentiae terminales, simplices vel parce ramosae, dense pilosae, pilis brunneis, patulis vel ascendentibus, usque ad 2 mm. longis, floribus secundis, densis; bracteae lanceolatae, usque ad 6 cm. longae, basi 5-10 mm. latae, apice longe filiformes, dense pilosae, pilis 1-3 mm. longis, brunneis; bracteolae bracteis similes sed minores, calycis segmenta anguste lanceolata, segmentum posterius et segmenta anteriora 3.5 cm. longa, 3 mm. lata, segmenta lateralia 2 cm. longa, 1.5 mm. lata, omnia filiformia, pilosa, pilis 1.5-4 mm. longis, brunneis; corolla rubra (?) 3 cm. longa, basi 2-3 mm. lata, sursum 8 mm. lata, tubo sursum minute pubescente, lobis ca. 3 mm. longis, 2.5 mm. latis, rotundatis; stamina 7 mm. exserta, filamentis parce pilosis; antherae 4 mm. longae, ventre minute pilosae, basi calcaratae. Fig. 2, H, I.

PERU: San Martín: Tarapoto, 750 m, December 1929, *L. Williams 6018* (US, type; F).

26. **Sanchezia villosa**, sp. nov.

Frutex 2-3 m. altus, caulibus quadrangularibus, sulcatis, angulis rotundatis, dense pilosis, pilis 2.5 mm. longis, patulis; foliorum lamina lanceolata, usque ad 20 cm. longa et 8 cm. lata, acuminata, basi angustata, basi ipsa cordata, firma, leviter crenata, supra subglabra, cystolithis conspicuis, 0.25-0.5 mm. longis, subtus costa et venis 14 paribus dense et alibi sparse pilosis, pilis ad 2.5 mm. longis, patulis vel ascendentibus, brunneis; petioli 4.5 cm. longi, dense pilosi, pilis brunneis, usque ad 2 mm. longis; spicae terminales et axillares, 12-18 cm. longae, floribus pluribus in fasciculis congestis, secundis; rhaches dense pilosae, pilis 2-3 mm. longis, brunneis, patulis vel ascendentibus; pedunculis 6 cm. longis, pilosis; bracteae lanceolatae, 2-5 cm. longae, basi 3-4 mm. latae, graciliter acuminatae, minute pilosae, plus minusve recurvatae; bracteolae usque ad 4 cm. longae, 2-3 mm. latae, apice graciliter acuminatae, pilosae, pilis usque ad 4 mm. longis; calycis segmenta anguste lanceolata, apice filamentosa, pilosa, segmentum posterius et segmenta anteriora usque ad 2 cm. longa, basi 2-2.5 mm. lata, segmenta lateralia usque ad 1.8 cm. longa et 1-2 mm. lata; corolla rubra, 4 cm. longa, basi 4 mm. lata, sursum 6 mm. lata, tubo

sursum pubescente, lobis ca. 3 mm. longis, 2.5 mm. latis (siccis), revolutis; stamina 5 mm. exserta; filamenta pilosa; antherae 3 mm. longae, ventre pilosae. Fig. 3, A.

PERU: San Martín: Tropical forest, Trocha, between Agua Blanca and Desquita, on road to Tarapoto, 600-800 m, July 24, 1950, *Ferreyra 7969* (US, type).

27. **Sanchezia aurea**, sp. nov.

Frutex volubilis, 1.5-2 m. altus, caulibus curvatis, quadrangularibus, dense pilosis, pilis 2-3 mm. longis, plerumque patulis, fusco-brunneis; foliorum lamina ovata vel elliptica, usque ad 15 cm. longa et 7 cm. lata, apice breviter acuminata, basi acuta, firma, integra vel leviter undulata, supra glabra vel parce pilosa, cystolithis multis, 0.5-1 mm. longis, conspicuis, subtus parce pilosa, costa et venis 8-10 paribus dense pilosis, pilis 1-1.5 mm. longis, patulis vel ascendentibus; petioli 1-2.5 cm. longi, dense pilosi; flores plures, in fasciculis secundis congestis; spicae terminales, una usque ad 12 cm. longa et 5 cm. lata, pedunculis 4 cm. longis, dense pilosis, spica basalis usque ad 8 cm. longa, 5 cm. lata, pedunculo 2 cm. longo; bracteae lineari-lanceolatae, usque ad 6 cm. longae, basi 3-5 mm. latae, sursum apice filiformi-productae, dense pilosae; bracteolae bracteis similes sed minores; calycis segmenta inaequalia, segmentum posterius et segmenta anteriora ad 3.5 cm. longa, segmenta lateralia 1.5-2 cm. longa, omnia ca. 1 mm. lata, pilosa; corolla 3 cm. longa, tubo basi ca. 2 mm. lato, sursum hirtello, aureo, lobis ca. 3 mm. longis, 2.5 mm. latis, rotundatis, erectis; stamina inclusa, pilosa. Fig. 3, B.

PERU: Huánuco: Forest, Hacienda Shapajilla near Tingo Maria, 600-700 m, August 10, 1946, *Ferreyra 887* (US, type: GH).

28. **Sanchezia stenomacra**, sp. nov.

Frutex 2-3 m. altus, caulibus subquadrangularibus, dense pilosis, pilis patulis, usque ad 2 mm. longis, brunneis vel subalbidis; foliorum lamina oblongo-ovata, usque ad 32 cm. longa et 6-15 cm. lata, breviter vel longe acuminata, apice saepe curvata, basi acuta vel subobtusa, integra, supra glabra vel in costa et venis 10-12 paribus parce hirsuta, cystolithis conspicuis, multis, 0.5 mm. longis, subtus parce pilosa vel glabra costa et venis longe pilosis exceptis, pilis brunneis, patulis vel ascendentibus; inflorescentiae terminales, simplices vel ramosae, dense pilosae, floribus pluribus in fasciculis congestis, secundis; spicae densae, laminis parvis vel bracteis basi 2-3 mm. latis, apice longe filiformibus productis, usque ad 8 cm. longis, dense pilosis suffultae; bracteae basi 4 mm. latae, apice filiformes, pilosae, usque ad 6 cm. longae; bracteolae similes; calycis segmenta filiformia, pilosa, 4 cm. longa; corolla aurantiaca et flava, 4 cm. longa, basi 4 mm. lata, sursum 6 mm. lata, minute pubescens, pilis retrorsis, lobis oblongis, 4 mm. longis et 3 mm. latis, rotundatis; stamina exserta 5-12 mm., filamentis pilosis, pilis patentibus, usque ad 2 mm. longis; antherae

Figure (3)

A: *Sanchezia villosa*, inflorescence × ½; B: *S. aurea*, leaf and stem section × ½; C: *S. stenomacra*, fascicle of inflorescence × ½; D: *S. rhodochroa*, leaf and stem section × ½; E: *S. aurantiaca*, leaf × ½; F: inflorescence × ½; G: sepal × 1; H: *S. klugii*, inflorescence × ½; I: calyx × 1; J: *S. coccinea*, leaf × ½; K: inflorescence × ½; L: sepal × 1.

5 mm. longae, parce et minute pilosae, basi calcaratae; staminodia 15 mm. longa, parce et minute pilosa. (From the Greek, *stenos, narrow*, and *macros, long*). Fig. 3, C.

PERU: HUÁNUCO: Tulumayo near Tingo Maria, *Mus. Nat. Univ. Lima 123* (US). LORETO: Forest, Balsapuerto, 220 m, April 1933, *Klug 3020* (US, type; F, GH, NY).

29. **Sanchezia filamentosa** Lindau, Bull. Herb. Boiss. II, 4: 314. 1904.

PERU: HUÁNUCO: Forests, Tingo Maria, *Asplund 12084* (S). LORETO: Near Pongo de Cainarachi, September 1902, *Ule 6401* (B, type; F photo 5889).

30. **Sanchezia rhodochroa,** sp. nov.

Frutex 3 m. altus, caulibus quadrangularibus, sulcatis, dense pilosis, pilis 3-4 mm. longis, patulis vel ascendentibus, brunneis, angulis rotundatis; foliorum lamina oblongo-lanceolata, ad 30 cm. longa, 7.5 cm. lata, apice acuminata, aliquando curvata, basi acuta, firma, integra vel leviter crenato-dentata, supra glabra, papillosa, cystolithis conspicuis, 0.25-0.5 mm. longis, subtus leviter pilosa, costa et venis plerumque 9 paribus dense pilosis, pilis 2-5 mm. longis, patulis vel ascendentibus; petioli ad 5.5 cm. longi, dense pilosi; flores plures in fasciculis congestis, his secundis; inflorescentiae terminales, sessiles vel ad 6 cm. pedunculatae; spicae 2-3, ad 16 cm. longae, sessiles vel ad 5 cm. pedunculatae, longe pilosae, pilis ad 4 mm. longis, patulis, brunneis; bracteae lineari-lanceolatae, ad 6 cm. longae, 5-6 mm. latae, apice longe filiformes; calycis segmenta lineari-lanceolata, apice filiformia, segmentum posterius 5-7 cm. longum, basi 4 mm. latum, segmenta anteriora 5.5 cm. longa, 3.5 mm. lata, segmenta lateralia 4 cm. longa, 2 mm. lata, omnia dense pilosa; corolla rosea, 4 cm. longa, basi 3 mm. lata, sursum 8 mm. lata, graciliter pubescens, lobis 3 mm. longis, 2.5 mm. latis, recurvatis; stamina vix exserta, parce pilosa; antherae 4 mm. longae, ventre minute pilosae, basi calcaratae; stylus glaber; capsula 15 mm. longa, glabra. (From the Greek, *rhodon, rose*, and *chros, colored*). Fig. 3, D.

PERU: SAN MARTÍN: Mountain forest, Chazuta, Río Huallaga, 260 m, April 1935, *Klug 4083* (US, type; F, GH, NY).

31. **Sanchezia aurantiaca,** sp. nov.

Frutex 2-2.5 m. altus, caulibus subquadrangularibus, glabris; foliorum lamina oblongo-elliptica, ad 20 cm. longa, 8 cm. lata, breviter acuminata, basi acuta, firma, utrinque glabra, integra vel undulata, costa et venis 6-8 paribus prominentibus, cystolithis pluribus, ad 0.5 mm. longis, conspicuis; petioli ad 4 cm. longi, glabri, canaliculati; inflorescentiae parce ramosae, floribus pluribus in fasciculis congestis; bracteae anguste ovatae, ad 23 mm. longae, basi ca. 7 mm. latae, acutae, basi rotundatae, apice ciliatae, parce hirsutae et nervosae, cystolithis pluribus, conspicuis, parallelis; bracteolae lanceolatae, 2

cm. longae, acutae, ciliatae, extus minute hirsutae, nervatae, cystolithis conspicuis; calycis segmenta lanceolata, 17-19 mm. longa, acuta, ciliata, pilis ad 1 mm. longis minute pubescentia, graciliter nervata; corolla aurantiaca, 5 cm. longa, basi 5 mm. lata, sursum 9 mm. lata, basi glabra, sursum minute pubescens, pilis tenuibus, patulis vel retrorsis, 0.4 mm. longis, lobis ovatis, 5 mm. longis, 4 mm. latis, rotundatis; filamenta ca. 8 mm. exserta, pilosa, pilis ad 2 mm. longis, articulatis; staminodia ca. 2 cm. longa. Fig. 3, E, F, G.

PERU: SAN MARTÍN: Prov. Mariscal Cáceres: Tropical forest, Quebrada Chambira near Juanjui, 200-300 m, August 24, 1948, *Ferreyra 4559* (US, type).

32. **Sanchezia klugii**, sp. nov.

Frutex vel arbor, 2.5-5 m. alta; ramis subquadrangularibus vel deorsum subteretibus, pilis appressis ad 0.5 mm. longis vestitis; foliorum lamina ovato-lanceolata, ad 20 cm. longa et 8 cm. lata, apice acuminata vel breviter acuminata, basi acuta, firma, integra, costa et venis (6-8 paribus) plus minusve appresse pilosis exceptis utrinque glabra, supra cystolithis conspicuis 0.25 mm. longis numerosis instructa; petioli 1-3 cm. longi, appresse pilosi; inflorescentia terminalis, simplex vel ramosa, 6-15 cm. longa, floribus densis, secundis instructa, rachibus pilosis, pilis 0.5 mm. longis, appressis instructis; bracteae anguste triangulares, 1-1.5 cm. longae, acuminatae, subcarinatae, appresse pilosae; bracteolae similes sed minores; nodi uniflori; calycis segmenta oblonga, 2-2.3 cm. longa, 2-3 mm. lata, apice aristata, extus minute pilosa; corolla 4 cm. longa, basi 3 mm. lata, sursum 8 mm. lata, apice 6 mm. lata, rubra vel rosea, apice minute pubescens, pilis 0.2-0.3 mm. longis, lobis rotundatis, recurvatis, 3 mm. longis et latis; stamina 5-12 mm. exserta, filamentis pilosis, pilis ad 2 mm. longis; antherae 4 mm. longae, parte ventralis minute pilosa, pilis 0.25 mm. longis, basi calcaratae; ovarium glabrum. Fig. 3, H, I.

PERU: SAN MARTÍN: Clearing in forest, Pongo de Cainarachi, on the Río Cainarachi, 230 m, September-October 1932, *Klug 2617* (US, type; F, GH, NY). Forest, Chazuta, Río Huallaga, 260 m, April 1935, *Klug 4117* (F, GH, NY, US).

33. **Sanchezia williamsii** Leonard, Journ. Washington Acad. Sci. **22**: 127. 1932.

PERU: SAN MARTÍN: Forest, San Roque, 1350-1500 m, January - February 1930, *L. Williams 7701* (US, type); *7215* (F, US).

34. **Sanchezia coccinea**, sp. nov.

Frutex 4 m. altus, caulibus subquadrangularibus, glabris, angulis obtusis; foliorum lamina lanceolata vel oblanceolata, ad 27.5 cm. longa et 9 cm. lata, apice acuminata, basi angustata, firma, integra vel leviter crenata, utrinque glabra, cystolithis obscuris, supra minute papillosa; petioli 1-2 cm. longi; inflorescentiae ramosae, pyramidales, ad 26.5 cm. longae et 14 cm. latae, floribus pluribus, in fasciculis

congestis, fasciculis contiguis vel basalibus laxis; bracteae ovatae, ad 15 mm. longae, 6 mm. latae, acutae, glabrae; bracteolae anguste ovatae, 10-15 mm. longae, 3-6 mm. latae, acutae, glabrae; calycis segmenta subrufo-violacea, oblongo-lanceolata, subaequalia, ad 22 mm. longa, 2-3 mm. lata, acuta vel acuminata, apice minute pilosula, interdum recurvata, marginibus hyalinis; corolla 4 cm. longa, coccinea, vel rosea deorsum glabra, sursum dense pilosa, pilis 0.5-0.75 mm. longis, retrorse adpressis, lobis 2.5 mm. longis, 2 mm. latis, marginibus recurvatis, extus retrorse pilosis, intus glabris, apice obtusis; filamenta pilosa, basi tomentosa; antherae 4.5 mm. longae, ventre minute pilosae, basi calcaratae; staminodia ca. 1 cm. longa, basi tomentosa; ovarium glabrum. Fig. 3, J. K. L.

PERU: HUÁNUCO: Forest, east of Divisoria, 1400 m, July 27, 1940, *Asplund 12588* (S). SAN MARTÍN: Near Arroyo Bravo on road to Divisoria, near Tingo Maria, 1200 m, November 1949 - January 1950, *Allard 21771* (US, type). Between Tingo Maria and Divisoria, August 13, 1946, *Ferreyra 981* (US).

35. **Sanchezia punicea,** sp. nov.

Frutex, caulibus glabris subquadrangularibus, angulis rotundatis; foliorum lamina oblongo-elliptica, ad 27 cm. longa, 12 cm. lata, graciliter caudato-acuminata, basi acuta, crenato-dentata, utrinque glabra, minute papillosa, cystolithis 0.5 mm. longis, obscuris; petioli ad 5 cm. longi, glabri; inflorescentiae paniculatae, pyramidatae, terminales, ad 23 cm. longae et 15 cm. latae, floribus pluribus in fasciculis congestis, fasciculis approximatis; bracteae parvae, triangulares, ad 7 mm. longae, basi 2.5 mm. latae, acriter acutae, carinatae, minute et parce puberulentae; bracteolae bracteis similes sed minores; calycis segmenta lanceolata, 17-22 mm. longa, segmentum posterius 3.5 mm. latum, segmenta anteriora 3 mm. lata, segmenta lateralia 2.5 mm. lata, omnia graciliter acuminata, subrubro-violacea, ciliata, parce pubescentia; corolla 3-4 cm. longa, basi 4 mm. lata, sursum 8 mm. lata, in fauce parce constricta, punicea, basi glabra, sursum pilosa, pilis gracilibus, 1-2 mm. longis, lobis 2.5 mm. longis, 2 mm. latis, rotundatis, revolutis; stamina inclusa; filamentis quam corollae tubo valde brevioribus, parce pilosis; staminodia 1.5 cm. longa. Fig. 4, A, B.

PERU: HUÁNUCO: Forest, Campamento Boza, between Pumahuasi and Divisoria, 1000 m, August 22, 1940, *Asplund 13248* (S, type); *13257* (S).

36. **Sanchezia woytkowskii,** sp. nov.

Frutex, caulibus subquadrangularibus, glabris; foliorum lamina late ovata vel elliptica, ad 25 cm. longa et 14.5 cm. lata, breviter acuminata, firma, glabra, marginibus leviter crenata, supra minute papillosa, utrinque costa et venis 9 paribus prominentibus, cystolithis obscuris; petioli ad 6 cm. longi, glabri; inflorescentia terminalis, pyramidata,

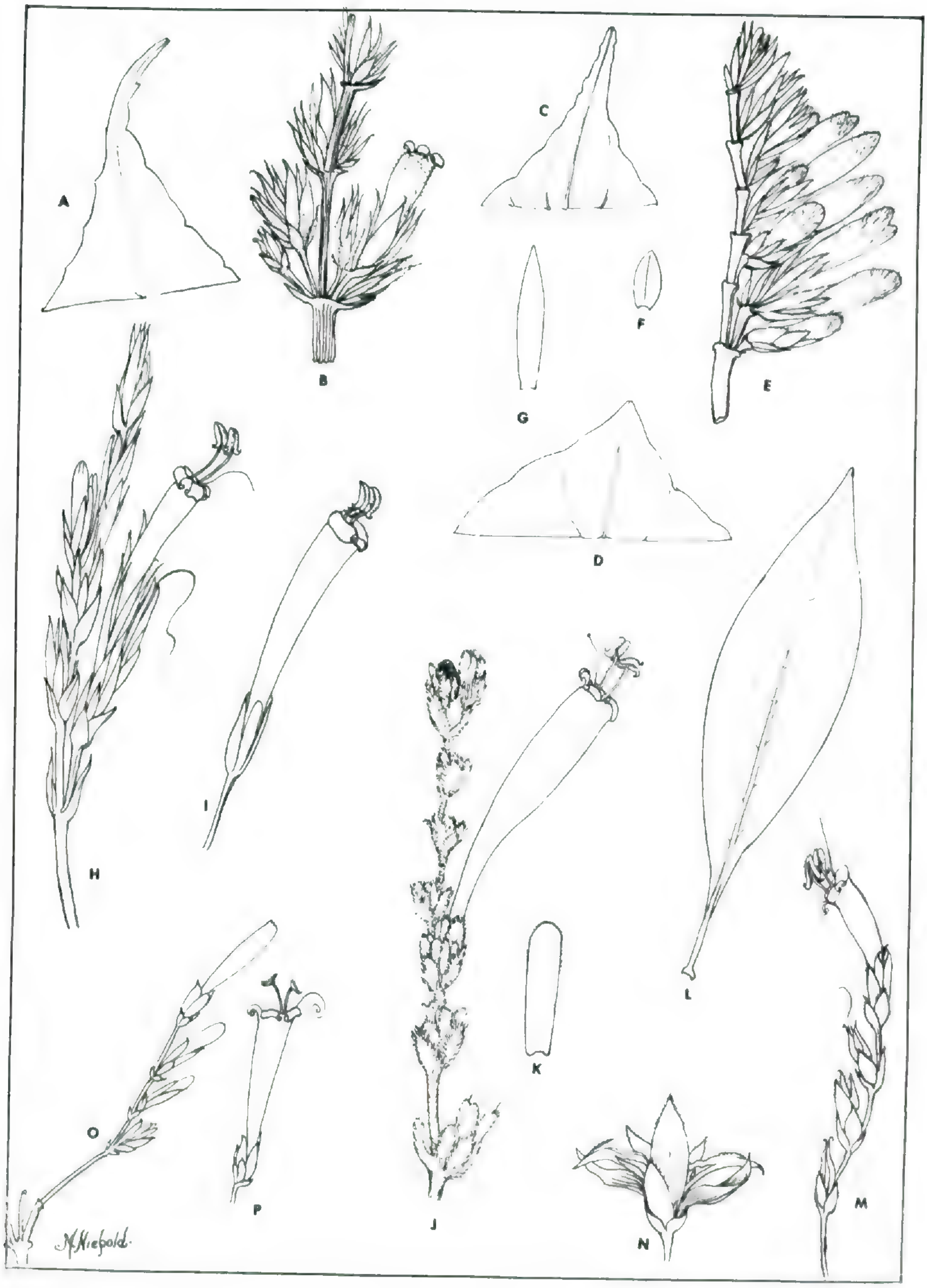

Figure (4)

A: *S. punicea*, leaf apex × ½; B: inflorescence × ½; C and D: *S. woytkowskii*, leaf apices × ½; E: inflorescence × ½; F: bract × 1; G: calyx segment × 1; H: *S. lampra*, inflorescence × ½; I: *S. pedicellata*, flower × ½; J: *S. lasia*, inflorescence × ½; K: calyx segment × 1; L: *S. ferreyrae*, leaf × ½; M: inflorescence × ½; N: fruit × 1; O: *S. arborea*, inflorescence × ½; P: flower × ½.

congesta, apice truncata, floribus ca. 3 in fasciculis congestis, fasciculis contiguis in spicis secundis; bracteae deciduae, angustae ovatae, ca. 8 mm. longae, 3-4 mm. latae, acutae, carinatae, minute hirsutae; bracteolae bracteis similes; calycis segmenta oblonga, ca. 15 mm. longa, 2-2.5 mm. lata, acuta, hirsuta; corolla rubra (?), 3-3.3 cm. longa, basi 3-4 mm. lata, sursum 7-8 mm. lata, in fauce constricta, deorsum glabra, supra parce pilosa, pilis plus minusve patulis, 1.5-2 mm. longis, lobis 3 mm. longis, 2.5 mm. latis, rotundatis, fere glabris, planis; filamenta quam corollae tubo longiora sed nonnunquam inclusa; antherae ovato-oblongae, 5 mm. longae, prope basim 2 mm. latae, ventre minute hirsutae, basi calcaratae; staminodia ca. 1 cm. longa, pilosa, pilis patulis, ad 1.5 mm. longis; ovarium glabrum. Fig. 4, C, D, E, F, G.

PERU: LORETO: Boquerón Padre Abad, 470 m, August 11, 1946, *Woytkowski 34359* (F, type); *34472* (F).

37. **Sanchezia rosea** Leonard, Journ. Washington Acad. Sci. **22:** 129. 1932.

PERU: LORETO: Woods, Yurimaguas, lower Río Huallaga, 135 m, August 25, 1929, *Killip & A. C. Smith 28040* (US, type; NY).

38. **Sanchezia sprucei** Lindau, Bull. Herb. Boiss. **5:** 648. 1897.

PERU: SAN MARTÍN: Near Tarapoto, *Spruce s. n.* (GH, isotype; F, US photos). San Roque, *Melin 134* (S); *356* (S).

39. **Sanchezia lampra,** sp. nov.

Frutex ad 2 m. altus, caulibus quadrangularibus, glabris, sulcatis; foliorum lamina lanceolata, ca. 40 cm. longa, 6.5 cm. lata, apice longe caudato-acuminata, basi attenuata, costa et venis lateralibus 10-11 paribus subtus perobscure pubescentibus exceptis utrinque glabra, cystolithis subdensis, ca. 0.2 mm. longis, tenuis, leviter undulata; petioli 2 cm. longi; inflorescentia terminalis, ramosa, ad 17 cm. longa, spicis strictis, floribus 2 in fasciculis congestis, haud secundis, fasciculis contiguis; bracteae triangulari-ovatae, 13 mm. longae, apice carinatae, cystolithis multis parallelis instructae, apice obscure pubescentes; bracteolae minores, oblongae, acutae; calycis segmenta oblonga, subaequalia, 18 mm. longa, 2.5-3 mm. lata, cuspidata, apice obscure pubescentia; corolla fulgente rubra, 4 cm. longa, basi 5 mm. lata, sursum attenuata dein 8 mm. lata, apice 6 mm. lata, glabra, lobis anguste ovatis, 4 mm. longis, recurvatis; stamina 12 mm. exserta; antherae 4.5 mm. longae, basi cuspidatae; staminodia elongata. Fig. 4, H.

ECUADOR: GUAYAS: Lowland along stream, 10 km. west of Pedro Carbo, July 22, 1940, *Haught 3082* (US, type).

40. **Sanchezia longiflora** (Hook.) Hook. f. ex Planch. Fl. des Serres **23:** 257, *pl. 2460*. 1883.

Ancylogyne longiflora Hook. Bot. Mag. **92:** *pl. 5588*. 1866.

ECUADOR: Near Guayaquil, *Pearce* (K, type).

41. **Sanchezia oxysepala** Mildbr. Notizblatt **9:** 983. 1926.
PERU: AMAZONAS: High land at the mouth of the Río Apaya, *Tessmann 3874* (NY). Mouth of Río Santiago, upper Río Marañon, *Tessmann 3874a* (B, type; US photo). Prov. Bagua: Rainforest along Quebrada Miraná (above km. 277 of Marañon road), valley of Río Marañon above Cascadas de Mayasi, 450-500 m, September 8, 1962, *Wurdack 1909* (US). LORETO: Undergrowth in dense forest, foothills of Sierra del Pongo, 400 m, November 29, 1931, *Mexia 6189* (F, GH, NY, US).

42. **Sanchezia pedicellata,** sp. nov.
Frutex ad 2 m. altus, caulibus subquadrangularibus, glabris; foliorum lamina oblongo-elliptica, ad 24 cm. longa et 10 cm. lata, obtusa vel breviter acuminata, utrinque glabra, firma, crenato-dentata, costa et venis lateralibus 14 paribus prominentibus, cystolithis obscuris, supra minute papillosa; petioli 6 cm. longi, crassi, glabri; inflorescentia terminalis, parce ramosa, floribus pluribus in fasciculis congestis; bracteae deciduae, brunneo-rubrae, lanceolatae, 1 cm. longae, ca. 2 mm. latae, obtusae (?), glabrae; pedicelli graciles, glabri, ad 12 mm. longi; calycis segmenta oblonga, 10-15 mm. longa, 3-4.5 mm. lata, apice rotundata, glabra; corolla fulgente rubra, 6 cm. longa, basi 3 mm. lata, sursum 6 mm. lata, in fauce leviter constricta, lobis ca. 4 mm. longis, 3 mm. latis, revolutis; filamenta 3-5 mm. exserta, parce pilosa, pilis ca. 1 m. longis, patulis; antherae 4 mm. longae, ventre minute hirsutae, basi calcaratae; staminodia ca. 12 mm. longa. Fig. 4, I.
PERU: LORETO: Jungle, Aguatía, 200 m, August 25, 1946, *Woytkowski 34427* (F, type).

43. **Sanchezia conferta** Leonard, Journ. Washington Acad. Sci. **22:** 131. 1932.
PERU: JUNÍN: Dense forest, Yapas, Pichis Trail, 1350-1600 m, June 29, 1929, *Killip & A. C. Smith 25479* (US, type). PASCO: Villa Rica, August 1955, *Soukup 4375* (US).

44. **Sanchezia lasia,** sp. nov.
Frutex 1.5-2 m. altus, caulibus glabris vel ad nodos tomentosis, subquadrangularibus; foliorum lamina oblongo-ovata vel elliptica, ad 22 cm. longa et 11 cm. lata, breviter acuminata (apice ipso obtuso), basi angustata, utrinque glabra, firma, integra vel leviter undulata, costa et venis 8-10 paribus prominentibus, cystolithis obscuris; petioli 4 cm. longi; inflorescentia terminalis, laxe paniculata, spicis ad 15 cm. longis, brunneo-tomentosis, internodiis infimis ad 2 cm. longis, aliis sursum sensim minoribus, apice contiguis, floribus pluribus in fasciculis congestis, secundis; bracteae ovatae, ad 1 cm. longae, 5-6 mm. latae, dense tomentosae; bracteolae bracteis similes sed minores;

calycis segmenta oblonga, 14 mm. longa, 3-3.5 mm. lata, apice rotundata, glabra vel apice plus minusve tomentosa, marginibus subhyalinis; corolla rosea, 5 cm. longa, basi 3-4 mm. lata, sursum 9 mm. lata, in fauce constricta, lobis 2.5 mm. longis et latis, rotundatis, revolutis; filamenta ca. 8 mm. exserta, pilosa, pilis 0.5-1 mm. longis, patulis vel recurvatis; antherae 4 mm. longae, ventre tomentosae, basi calcaratae. (Name from the Greek, *lasios, shaggy*). Fig. 4, J, K.

PERU: HUÁNUCO: Tropical forest, La Merced, 400-500 m, August 14, 1948, *Ferreyra 4467* (US, type). SAN MARTÍN: Riverbank, Juan Jui, upper Río Huallaga, 400-800 m, May 1936, *Klug 4380* (F, GH, NY, US).

45. **Sanchezia scandens** (Lindau), comb. nov.

Steirosanchezia scandens Lindau, Bull. Herb. Boiss. II. 4: 317. 1904; Mildbr. Notizblatt 9: 983. 1926.

PERU: LORETO: Yurimaguas, August 1902, *Ule 6286* (B, type; F photo 5884). Pongo de Manseriche, 155 m, August 27, 1924, *Tessmann 3880* (Bassler Herb., Iquitos, Peru; US photo). La Victoria on the Amazon River, August-September 1929, *L. Williams 2616* (F, US). Puerto Arturo, lower Río Huallaga, August-September 1929, *L. Williams 5248* (F). SAN MARTÍN: Tarapoto, Río Mayo, 360-900 m, December 1929, *L. Williams 6264* (F, US).

46. **Sanchezia sylvestris** Leonard, Journ. Washington Acad. Sci. 22: 128. 1932.

PERU: LORETO: Dense forest, between Yurimaguas and Balsapuerto, 135-150 m, August 26, 1929, *Killip & A. C. Smith 28093* (US, type; F, NY).

47. **Sanchezia ferreyrae**, sp. nov.

Frutex 4-5 m. altus, caulibus subquadrangularibus, glabris; foliorum lamina oblongo-elliptica, ad 12 cm. longa, 3.5 cm. lata, breviter acuminata (apice ipso obtuso), basi angustata, firma, integra vel undulata, utrinque glabra, costa et venis ca. 8 paribus prominentibus, cystolithis obscuris; petioli 1 cm. longi; inflorescentia terminalis, parce ramosa, foliosa, floribus secundis, solitariis, imbricatis; bracteae purpureae, ovatae, 7 mm. longae, 3 mm. latae, acuminatae, ciliatae, costa parce strigosa, pilis 0.25 mm. longis, cystolithis pluribus, parallelis; bracteolae bracteis similes sed paulo longiores; calycis segmenta oblonga, 15 mm. longa, 3.5-4.5 mm. lata, acuta, apice ciliata, venis tenuibus, marginibus subhyalinis; corolla rubra, glabra, 3 cm. longa, basi 3 mm. lata, sursum 7 mm. lata, in fauce leviter constricta, lobis ca. 4 mm. longis, 3 mm. latis, revolutis; filamenta ca. 6 mm. exserta, parce pilosa, pilis patulis, ad 1 mm. longis; antherae 4 mm. longae, ventre minute hirsutae, basi calcaratae; capsula glabra, lanceolata, 1.5 cm. longa, 4 mm. lata, 2.5 mm. crassa, acuta; retinacula 2 mm. longa, apice plana; semina (immatura) lenticularia, glabra, 3.5 mm. longa, ca. 1.5 mm. lata. Fig. 4, L, M, N.

PERU: HUÁNUCO: Prov. Pachitea: Tropical forest, La Merced, between Situlli and Cerro Santa Cruz, 86 km. from Tingo María, 500-600 m, August 3, 1948, *Ferreyra 4392* (US, type).

48. **Sanchezia arborea,** sp. nov.

Arbor 4 m. alta, caulibus glabris, subquadrangularibus, angulis rotundatis vel deorsum subteretibus; foliorum lamina lanceolata vel oblongo-elliptica, apice acuminata, saepe curvata, basi angustata, ad 16 cm. longa, 4 cm. lata, utrinque glabra, cystolithis minutis et obscuris; petioli 0.5-2 cm. longi, glabri; inflorescentia terminalis, parce ramosa, glabra, floribus solitariis, secundis, racemis laxis, ad 8 cm. longis; bracteae ovatae, 3 mm. longae et latae, apice rotundatae, apiculatae, glabrae sed marginibus parce ciliolatis; bracteolae ellipticae, 4.5 mm. longae; calycis segmenta glabra, oblonga, 1-1.5 cm. longa, 2.4 mm. lata, apice apiculata, minute ciliolata, marginibus hyalinis; corolla rubroviolacea, glabra, 3.5-4 cm. longa, basi 2 mm. lata, sursum 5-7 mm. lata, lobis rotundatis, 3 mm. longis, 2 mm. latis, revolutis; stamina exserta 5-8 mm., filamentis glabris; staminodia 8 mm. longa, apice parce puberula; antherae 1.5 mm. longae, apice acutae, basi calcaratae, ventre puberulae; ovarium glabrum. Fig. 4, O, P.

PERU: SAN MARTÍN: Clearing in forest, Pongo de Cainarachi, Río Cainarachi, 230 m, September-October 1932, *Klug 2612* (US, type; F, GH, NY).

49. **Sanchezia decora,** sp. nov.

Frutex 2 m. altus, ramis glabris, subquadrangularibus, angulis rotundatis deorsum teretibus; foliorum lamina lanceolata vel oblongo-elliptica, acuminata, apice ipso obtuso, basi angustata, ad 14 cm. longa, 4 cm. lata, utrinque glabra, cystolithis minutis, obscuris; petioli 1-2 cm. longi, glabri; inflorescentia terminalis, parce ramosa, glabra, floribus solitariis, secundis, spicis laxis, ad 7 cm. longis; bracteae lanceolatae, 2-4 mm. longae, 1 mm. latae, acutae; bracteolae ovatae, 4.5 mm. longae, 2.5 mm. latae, rotundatae, apiculatae, glabrae, marginibus minute ciliolatis; calycis segmenta oblonga, ad 12 mm. longa, obtusa, rotundata vel truncata, glabra, apice minute ciliolata, marginibus hyalinis; corolla lilacino-rosea, 3.5-4 cm. longa, basi 2-3 mm. lata, sursum 6 mm. lata, glabra, lobis 3 mm. longis, 2.5 mm. latis, rotundatis, revolutis; stamina 5 mm. exserta, filamentis glabris, basi puberulis et tomentosis; staminodia 12 mm. longa, parce puberula, basi tomentosa; antherae 4.5 mm. longae, ventre puberulae; ovarium glabrum. Fig. 5, A, B, C.

PERU: SAN MARTÍN: Clearing in forest, Pongo de Cainarachi, Río Cainarachi, 230 m, September-October 1932, *Klug 2616* (US, type; F, GH, NY).

50. **Sanchezia lispa,** sp. nov.

Frutex 4 m. altus, caulibus subquadrangularibus, glabris, angulis

Figure (5)

A: *Sanchezia decora,* inflorescence × ½; B: flower × ½; C: calyx × 1; D: *S. lispa,* inflorescence × ½; E: calyx × 1; F: *S. skutchii,* leaf × ½; G and H: inflorescence sections × ½; I: calyx × 1; J: *S. tarapotensis,* leaf × ½; K: inflorescence × ½; L: calyx × 1.

rotundatis; foliorum lamina oblongo-elliptica, ad 17 cm. longa et 6 cm. lata, apice breviter acuminata, basi angustata, utrinque glabra, costa et venis lateralibus 8 paribus prominentibus, cystolithis ad 0.5 mm. longis; petioli 5-10 mm. longi, glabri; spica terminalis, simplex, glabra, floribus 1-2 in axillis bractearum; bracteae ovatae, 8 mm. longae, 3.5-4 mm. latae, obtusae vel rotundatae, apiculatae; bracteolae bracteis similes vel paulo longiores; calycis segmenta 13 mm. longa, 4 mm. lata, glabra, apice obtusa, apiculata; corolla 4 cm. longa, aureo-rubra, glabra, lobis ca. 5 mm. longis, 3 mm. latis, apice rotundatis, apiculatis, revolutis; filamenta ad 12 mm. exserta, glabra vel parce pilosa, pilis 0.5 mm. longis; antherae 4 mm. longae, ventre minute hirsutae, basi calcaratae; staminodia ca. 2 cm. longa. (Name from the Greek, *lispos, smooth*). Fig. 5, D, E.

PERU: HUÁNUCO: Forest, Tingo Maria, July 31, 1940, *Asplund 12654* (S, type).

51. **Sanchezia putumayensis** Leonard, Contr. U. S. Nat. Herb. **31:** 55, *fig. 20.* 1951.

Sanchezia sylvestris Leonard, Journ. Washington Acad. Sci. **22:** 128. 1932, in part, not as to type.

COLOMBIA: NARIÑO: Barbacoas, *Triana s. n.* (COL). PUTUMAYO: Forest, Río Putumayo, September-October 1930, *Klug 1653* (US, type; GH, MO, NY). Rain forest, Río San Miguel at the mouth of the Río Conejo, 300 m, December 9, 1940, *Cuatrecasas 10919* (US).

52. **Sanchezia tigrina** Leonard, Journ. Washington Acad. Sci. **22:** 130. 1932.

PERU: LORETO: Iquitos, 120 m, October 1929, *L. Williams 3622* (US, type; F). Garden site, Iquitos, 90 m, September 1942, *Sandeman 3289* (K).

53. **Sanchezia parviflora** Leonard, Journ. Washington Acad. Sci. **16:** 491. 1926.

ECUADOR: ORO: Between Santa Rosa and La Chorita, 0-100 m, August 27, 1923, *Hitchcock 21127* (US, type). GUAYAS, CAÑAR, CHIMBORAZO, and BOLÍVAR (junction): Foothills of the western cordillera near the village of Bucay, 1000-1250 m, June 8-15, 1945, *Camp E-3756* (NY, US).

54. **Sanchezia lutea** Leonard, Contr. U. S. Nat. Herb. **31:** 53, *fig. 19.* 1951.

COLOMBIA: CAQUETÁ: Florencia, *Camilo 78* (GH). CHOCÓ: Headwaters of Río Tutunendo, east of Quibdó, May 20, 21, 1931, *Archer 2174* (US, type). Rocky margins of Río Atrato above Yuto, 70 m, April 2, 1958, *Cuatrecasas & Llano 24127* (US). META: Los Llanos, between Villavicencio and El Parrao, 500 m, November 10, 1938, *Cuatrecasas 4627* (US).

55. **Sanchezia loranthifolia** Lindau, Bull. Herb. Boiss. II, **4:** 314. 1904.

PERU: LORETO: San Pedro, Río Cumbaso, March 1903, *Ule 6820* (B, type: F photo 5890).

56. **Sanchezia skutchii,** sp. nov.

Frutex 3 m. altus, caulibus quadrangularibus, sulcatis, glabris; foliorum lamina lanceolata, ad 16 cm. longa et 5 cm. lata, apice longe caudato-acuminata, basi acuta, utrinque glabra, costa et venis lateralibus 8-10 paribus prominentibus, firma, supra papillosa, cystolithis obscuris; petioli ca. 1.5 cm. longi, glabri; inflorescentia terminalis, multiramosa, fere glabra, spicis sublaxis, ad 13 cm. longis, floribus 2-4 in fasciculis congestis vel raro solitariis; bracteis basalibus linearibus, ca. 8 mm. longis, dein brevioribus et latioribus, omnibus glabris; bracteolis late ovatis, 8 mm. longis; calycis segmenta oblonga, 13 mm. longa, ad 4 mm. lata, apice minute ciliolata; corolla rubra, 4 cm. longa, basi 3 mm. lata, sursum 9 mm. lata, ad apicem versus retrorso-pilosa, pilis 0.25 mm. longis, lobis late ovatis, 4 mm. longis, 3.5 mm. latis, rotundatis, recurvatis; filamentis 15-17 mm. exsertis, sparse pilosis; antherae 5 mm. longae, basi cuspidatae. Fig. 5, F. G. H, I.

ECUADOR: NAPO-PASTAZA: Near Puyo, eastern foothills of the Andes, 750-1000 m, September 1939, *Skutch 4500* (US, type).

57. **Sanchezia tarapotensis,** sp. nov.

Herba verisimiliter alta, caulibus quadrangularibus, sulcatis, glabris, angulis rotundatis; foliorum lamina elliptico-lanceolata, ad 20 cm. longa et 6 cm. lata, apice acuminata, basi acuta, utrinque glabra, costa et venis lateralibus 8-11 paribus prominentibus, subtenuis, supra papillosa, cystolithis subdensis, 0.5 mm. longis; petioli vix ultra 5 mm. longi, supra dense sericeo-vestiti, alibi glabri; inflorescentia simplex vel pauciramosa, glabra, spicis laxis vel sublaxis, 11-16 cm. longis, floribus 2-4 in fasciculis congestis; bracteae basales anguste ovatae, ad 25 mm. longae, 6 mm. latae, dein multo breviores; bracteolae subellipticae, ad 14 mm. longae, bracteas superiores superantes; calycis segmenta oblonga, longitudine subaequalia, ad 20 mm. longa et 3.5 mm. lata, rotundata et apiculata; corolla unica imperfecte cognita, citrina, 4 cm. longa, sursum 7 mm. lata, ad apicem versus retrorso-pilosa, lobis 3 mm. latis recurvatis; stamina ignota; stylus exsertus. Fig. 5, J, K, L.

PERU: TARAPOTO: Forest near Tarapoto, 400-420 m, July 18, 1950, *Ferreyra 7883* (US, type).

58. **Sanchezia parvibracteata** Sprague & Hutchinson, Kew Bull. **1908:** 253. 1908; Leonard, Journ. Washington Acad. Sci. **16:** 492. 1926; Contr. U. S. Nat. Herb. **31:** 56. 1951.

Sanchezia sprucei var. *salvadorensis* Donn. Smith, Bot. Gaz. **44:** 116. 1907.

MEXICO: CHIAPAS: Escuintla, December 16, 1936, *Matuda 128* (US).

GUATEMALA: QUEZALTENANGO: Gardens of San Francisco Miramar, 660 m, March 15, 1921, *Tonduz & Rojas 165* (US).

SALVADOR: Garden, Salvador, 1905, *Renson 112* (US). Same, December 1906, *Velasco 8985* (US, type of *Sanchezia sprucei* var. *salvadorensis* Donn. Smith).

COLOMBIA: PUTUMAYO: Banks of the Río Güamués between San Antonio and the mouth, 270-310 m, December 20, 1940, *Cuatrecasas 11231* (US).

59. **Sanchezia ecuadorensis** Leonard, Journ. Washington Acad. Sci. **16:** 492. 1926.

ECUADOR: TUNGURAHUA: Valley of Pastaza River, between Baños and Cashurco, 1300-1800 m, September 25, 1923, *Hitchcock 21833* (US, type).

EXSICCATAE CITED IN SANCHEZIA

(Number of the species in parentheses)

ALLARD 21711 (8); 21771 (34); 21883 (13); 22183 (13); 22432 (13). ALLEN, P. H., 269 (4); 4300 (4). ARCHER 2174 (54). ASPLUND 12081 (13); 12084 (29); 12086 (9); 12587 (13); 12588 (34); 12654 (50); 13248 (35); 13257 (35); 14448 (18).

BANG 1473 (13). BEARD, P., 1274 (16).

CAMILO 78 (54). CAMP E-3756 (53). CUATRECASAS 4627 (54); 10919 (51); 11231 (58); 24127 (54). CURTISS, A. H., 622 (16).

DIERS 1227 (13). DUSS 835 (16).

EKMAN H-2204 (16).

FERREYRA 887 (27); 981 (34); 1612 (13); 1664 (13); 4211 (9); 4220 (13); 4275 (22); 4391 (5); 4392 (47); 4467 (44); 4559 (31); 5156 (9); 7883 (57); 7969 (26).

GINES 4919 (4).

HAUGHT 3082 (39). HITCHCOCK 21127 (53); 21801 (14); 21833 (59).

JIMÉNEZ 3049 (16).

KILLIP & A. C. SMITH 22954 (13); 23205 (13); 23411 (13); 24080 (11); 24640 (17); 25271 (1); 25287 (9); 25472 (9); 25479 (43); 26207 (9); 26447 (18); 26768 (20); 27842 (18); 27993 (4); 28040 (37); 28093 (46); 28829 (4); 28967 (24); 29549 (13); 30208 (19). KLUG 667 (13); 1653 (51); 2612 (48); 2616 (49); 2617 (32); 2671 (23); 3020 (28); 3478 (13); 4083 (30); 4117 (32); 4380 (44).

LIMA, MUS. NAT. UNIV. 123 (28).

MACBRIDE 4634 (9); 4665 (20); 5056 (13). MARTIUS s. n. (19). MATHEWS 1221 (13); 1230 (2); 2013 (13); 3168 (13). MATUDA 128 (58). MELIN 134 (38); 349 (13); 356 (38); 368 (13). MEXIA 6189 (41).

PEARCE s. n. (15); s. n. (40). PENNELL 3798 (4). PITTIER, H. 6527 (4).

RENSON 112 (58). RODRIGUEZ s. n. (18). RUIZ & PAVÓN s. n. (7); s. n. (9); s. n. (12).

SANDEMAN 3289 (52). SCHULTES, R. E., 6607 (6a); 6937 (6b). SCHUNKE 1758 (13). SKUTCH 4498 (21); 4500 (56). SOUKUP 819 (13); 2282 (13); 4375 (43); 4376 (13). SPRUCE s. n. (38). STEYERMARK 54127 (10). STORK, HORTON & VARGAS 10492 (13).

TESSMANN 3134 (3); 3874 (41); 3874a (41); 3880 (45); 5423 (3). TONDUZ & ROJAS 165 (58). TRIANA s. n. (51).

ULE 6286 (45); 6401 (29); 6820 (55).

VAN HERMANN 2700 (16). VARGAS 2131 (13); 3240 (13). VELARDE 4816 (9). VELASCO 8985 (58). VÉLEZ 3230 (16).

WILLIAMS, L., 380 (20); 1906 (13); 2616 (45); 2880 (20); 3622 (52); 5143 (20); 5248 (45); 6018 (25); 6264 (45); 6933 (13); 7215 (33); 7701 (33). WILLIAMS, R. S., 659 (4). WOYTKOWSKI 5794 (1); 34359 (36); 34427 (42); 34472 (36). WURDACK 1909 (41).

Suessenguthia Merxm.

Mitteil. Bot. Staatss. München [1], Heft **6**: 178, *pl. 1953*.

Characters of *Sanchezia*, but 4 fertile stamens. A single species.

1. **Suessenguthia trochilophila** Merxm. *l. c.*

Sanchezia peruviana sensu Rusby, Bull. New York Bot. Gard. **4**: 429. 1907, in part, as to *Bang 2367*, not as to basonym; sensu Leonard, Journ. Washington Acad. Sci. **16**: 487. 1926, in part, as to *Buchtien 1403* and *Bang 2367*, not as to basonym.

BOLIVIA: BENI: Rurrenabaque, 300 m, November 1921, *Rusby 850* (NY, US). LA PAZ: Wet sand near river, in shade, near Coroico, Yungas, August 2, 1894, *Bang 2367* (GH, NY, US, paratype number of *Suessenguthia trochilophila*). Guanai, 600 m, May 1886, *Rusby 1119* (US). Woods, San Carlos, Mapiri, 700 m, August 1907, *Buchtien 1403* (NY, US). San Bartolome (near Calisaya), basin of Río Bopi, Prov. S. Yungas, 750-900 m, July 1929, *Krukoff 10186* (US). Asunta (near Evenay), Prov. S. Yungas, 690-750 m, July 1939, *Krukoff 10585* (US).

For distinguishing imperfect material see key to *Sanchezia*.

Trichosanchezia Mildbr.

Notizblatt **9**: 984. 1926.

Characters of *Sanchezia*, but 4 fertile unappendaged stamens. A single species.

1. **Trichosanchezia chrysothrix** Mildbr. l. c.

PERU: AMAZONAS: Brookbank in forest, mouth of the Río Santiago, upper Río Marañon, 160 m, September 11, 1924, *Tessmann 4011* (B, type).

For distinguishing imperfect material see key to *Sanchezia*.

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SPECIES CROSSES IN HELIANTHUS: II. POLYPLOID SPECIES[1]

C. B. Heiser and D. M. Smith

Cytological studies of interspecific hybrids in *Helianthus* have, with few exceptions, shown that a high degree of interspecific chromosomal homology exists. The exceptions are of special interest in that they supply us with important clues concerning the interrelationships of species or groups of species. How important such clues may be in answering questions concerning the origin of the polyploid species is not yet clear,

The work of Kostoff (1939) on the hybrid *H. tuberosus* × *annuus* provides us with the first important cytogenetic study relating to the problems surrounding the origin of polyploid sunflowers. He discovered that this hybrid of a hexaploid perennial ($2n = 102$, *H. tuberosus*) and a diploid annual ($2n = 34$, *H. annuus*) often formed 34 bivalents in meiosis. He concluded that the chromosomes of *H. annuus* were essentially homologous with one genome of *H. tuberosus*, and that the remaining 17 bivalents resulted from autosyndesis of 2 sets of *H. tuberosus* chromosomes. This auto-allopolyploid interpretation of *H. tuberosus* has remained essentially unchallenged although Darlington (1956) implies that it is an autoploid of *H. annuus*.

Several interesting questions are posed by Kostoff's work. (1) Is the genomic composition of *H. tuberosus* unique for the genus or are other hexaploid species similarly constituted? (2) Is there additional evidence for the existence of A and B genomes in *Helianthus*, and if so, what is the source of the B genome in *H. tuberosus?* Some of the information accumulated by us on crossing relationships and cytology in *Helianthus* bears directly on these problems. The pertinent observations are these: (1) annual sunflowers (all of which are diploid) probably possess the same basic genome (B

[1]These studies have been supported in part by grants from the National Science Foundation (G-14826, G-19402).

genome of Kostoff), but the individual species have undergone considerable chromosomal differentiation through reciprocal translocation (Heiser 1961). (2) Most diploid perennial sunflowers show exceedingly close chromosomal constitutions among themselves, but their genome differs from the "annual" genome (Heiser, Martin and Smith 1962), (3) tetraploid sunflowers (all perennials) are either autoploid or are segmental allopolyploids based on the "perennial" genome (A genome of Kostoff) (Smith 1961), (4) hybrids between *H. annuus* (diploid) and *H. decapetalus* (tetraploid) typically produce 17 bivalents and 17 univalents during meiosis (Heiser and Smith 1960), this being interpreted as a case of autosyndesis of the *H. decapetalus* chromosomes and asynapsis of the *H. annuus* chromosomes. Although no absolute proof can be given that the asynaptic chromosomes are indeed those of *H. annuus*, circumstantial evidence strongly supports this conclusion. (5) Clevenger and Heiser (1963) have shown that *H. tuberosus* crosses readily with *H. rigidus*, and that meiosis in these hybrids is essentially the same as in the parental species. Therefore, *H. rigidus* is genomically similar to *H. tuberosus*.

This paper is a presentation of the results of additional studies of hybridization involving polyploid sunflowers and a discussion of these results in terms of the genomic constitution and origin of the polyploid species of the genus and their relationships to the taxonomic complexities of the genus.

MATERIALS AND METHODS

Plants used in this study were usually obtained from wild populations and were propagated from seeds or as clonal transplants in experimental gardens and greenhouses. Voucher specimens are preserved in the Indiana University Herbarium. Cytological observations were made on microsporocytes prepared by the acetocarmine squash technique. Estimates of fertility were based upon the stainability of pollen grains in aniline blue in lacto-phenol. Chromosome doubling was obtained either by applying a few drops of .2% solution of colchicine by eyedropper to vegetative buds over a period of days or by growing young seedlings

for 8 hours on filter paper saturated with a .2% solution of colchicine. Although only a small number of polyploids was secured by either method, the treatment of seedlings proved the more successful.

TETRAPLOIDS

Five of the six species known to include tetraploids ($n = 34$) are distributed in eastern and central North America, and their similar morphology as well as the results of cytogenetic studies indicate that they are closely related (Fig. 1). The sixth, *H. ciliaris*, occurring in the southwestern United States and northern Mexico, is significantly different in gross morphology, and has not been successfully hybridized with the other tetraploid sunflowers.

The hybrids *H. decapetalus* × *strumosus* and *H. strumosus* × *hirsutus* have been described previously (Smith, 1961). The following additional hybrids may now be reported.

H. decapetalus × *laevigatus* and reciprocal (H476a+b). Four of the F_1 hybrids showed over 90% pollen stainability and the fifth gave a count of 43%. Seed set was good in all the plants. Meiotic chromosome behavior was examined in two of the plants and was not significantly different from that observed in the parents. Many cells showed 34 pairs, but occasional cells were observed in which one or two quadrivalents were present. An F_2 family (H655) of 21 plants was grown. Five of the plants died, four were extremely weak, but the remainder were vigorous. Pollen stainability ranged from 30 to 99% with a mean of 66%.

H. hirsutus × *smithii*[2] (H572b). Five hybrids were ob-

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[2]**Helianthus smithii,** Heiser, *nom. nov.*, *H. parviflorus* var. *attenuatus* A. Gray Syn. Fl. N. Am. 12: 278. 1884. (T.: Georgia, Rabun Co., near Talullah Falls, *J. Donnell Smith 6* (GH!). Alab. Randolph Co., 3 mi. n. of Wedowee, *D. M. Smith 1482*, K44 (IND). *Helianthus parviflorus* Bernh. is a synonym of *H. microcephalus* Torrey and Gray, and the name *H. attenuatus* is already occupied. Thus, it is necessary to supply a new name for this species. Its affinities apparently are with *H. strumosus* rather than with *H. microcephalus*. Since two Smiths have been concerned with making this sunflower known, this particular specific epithet seems most appropriate. — C. B. H.

Fig. 1-6. Camera lucida drawings of meiotic chromosomes in *Helianthus*, × approx. 950.

Fig. 1. *H. hirsutus* × *decapetalus* (6224), 34_{II}.

Fig. 2. Colchicine induced tetraploid of *H. microcephalus* × *giganteus* (C6371), $32_{II}1_{IV}$.

Fig. 3. *H. resinosus* × *tuberosus* (P130a), $49_{II}1_{IV}$.

Fig. 4. Colchicine induced tetraploid of *H. decapetalus* (P412c), $28_{II}3_{IV}$.

Fig. 5. *H. strumosus* × *annuus* (H626c), $17_{II}17_{I}$.

Fig. 6. *H. schweinitzii* × *smithii* (H474b), $34_{II}17_{I}$.

Overlapping chromosomes in fig. 3-6 have been moved in drawing.

tained from this cross and were fertile, with pollen stainability ranging from 80 to 99%, with a mean of 92% and good seed set. Meiosis was of the typical tetraploid sunflower pattern, with one or two quadrivalents, and with the remaining chromosomes forming bivalents.

Hybrids have also been obtained between *H. smithii* and *decapetalus* (H571a), and *H. smithii* and *strumosus* (6250). These plants showed 87% or better pollen stainability. They were not analyzed cytologically.

Colchicine-induced tetraploids have been obtained from three perennial hybrids and one perennial species. The tetraploids of hybrid origin (*H. giganteus* × *microcephalus* 325076, 1 plant; *H. microcephalus* × *giganteus* C6370, 2 plants; and *H. maximiliani* × 2*n decapetalus*, C6371, 2 plants) were essentially similar morphologically to the diploid hybrids from which they were derived except for slightly larger heads. All of them showed over 90% pollen stainability, although seed set was somewhat reduced. Meiosis was also essentially similar in all five of the plants with one to three quadrivalents being observed in most cells (Fig. 2) and an occasional cell showing 34 pairs. The one successful doubling of a diploid species involved *H. decapetalus* (P412c). In 28 cells studied at diakinesis from one to five quadrivalents were observed with the remainder of the chromosomes associated as bivalents. The most frequently observed configuration was 28_{II} and 3_{IV} (Fig. 4). Unfortunately the plant was lost before fertility was determined.

One other hybrid has been obtained that bears on the origin of the tetraploids. This cross involved *H. hirsutus* as the female parent and a diploid form of *H. decapetalus* (6224). This plant, however, was tetraploid rather than the expected triploid. Since it was morphologically more or less intermediate between the parents it seems likely that it is a hybrid involving an unreduced gamete of the diploid parent. The plant showed 93% pollen stainability and 34 pairs in each of the seven cells examined.

HEXAPLOIDS

Seven taxa which are regarded as species are hexaploid

($2n = 102$), although two of these also include tetraploid races *(H. ciliaris, H. strumosus)*. If Watson's (1929) treatment of the genus were to be followed, many more hexaploid species would be recognized. However, his additional taxa are very difficult to justify even on morphological grounds, and when other biological criteria are considered, their justification becomes even more difficult. Two of the species under consideration here, *H. strumosus* and *H. tuberosus*, are widespread in eastern North America, and *H. rigidus* is a common species of the mid-continent region, its range overlapping the ranges of the two preceding species over a large area. The two western American species, *H. ciliaris* and *H. californicus*, have not been hybridized with the other hexaploids even though several attempts have been made. The two remaining species are restricted to the southeastern United States, *H. schweinitzii* occurring in only a few localities in North Carolina, and *H. resinosus*[3] being widespread in the Southeast, but not common. The five eastern hexaploids have now been connected by a series of crosses.

The following hybrid combinations have been successful: *H. resinosus* × *schweinitzii* (H451a+b), *H. resinosus* × *strumosus* (H475a+b, K70a+b, K130, K199, K200), *H. resinosus* × *tuberosus* (P130a+b), *H. rigidus* × *strumosus* (H457a), *H. rigidus* × *tuberosus* (see Clevenger & Heiser, 1963), *H. schweinitzii* × *tuberosus* (K88a, K138 a+b), *H. strumosus* × *tuberosus* (P176a+b). Reciprocal hybrids were obtained in every case except *H. rigidus* × *strumosus*, in which seed germination failed in the reciprocal cross. The results of hybridization were so similar in each case that they need not be discussed separately. The F_1 generation

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[3]This name is being used to replace *H. tomentosus* of authors. Jones and Fuller (1955) were apparently the first to note the misapplication of the name *H. tomentosus* Michx. by American authors. We agree that Michaux was referring to an Illinois plant (although we have not seen the type) but disagree that extant Illinois plants should be called *H. tomentosus*. The material so designated by Jones and Fuller (1955) and Jones (1963) is well within the range of our concept of *H. tuberosus*. The next available name for the hexaploid southeastern sunflower in question is *H. resinosus* Small, Fl. S. E. U. S., p. 1269 1903. (T.: Fla., Gadsden Co., *Nash 2581*. NY!).

was highly fertile (85-100% stainable pollen) and vigorous, and essentially intermediate between the two parents in gross morphology, with the exception of certain features in the hybrid of *H. schweinitzii* × *tuberosus*. The parents of this hybrid differ strikingly in the nature of their underground perennating organs; *H. schweinitzii* has diffuse fleshy roots with new growth arising either directly from these or from the stem base, while *H. tuberosus* has long rhizomes which terminate in fleshy tubers, the latter constituting the source of the next season's growth. The hybrid has both fleshy roots *and* short tuber-bearing rhizomes. The study of meiosis in hexaploid sunflowers is difficult, but all available evidence suggests that the F_1 hybrids do not differ significantly from their parents in meiotic behavior. Meiosis is somewhat irregular in that multivalents are encountered in most cells (Fig. 3). The number of multivalents (probably quadrivalents) ranges from 1 to 4, with the other chromosomes forming bivalents.

A few small backcross and F_2 families of several combinations have been grown which showed a wide range of morphological expression, but little weakness or sterility was encountered.

Many crosses have been attempted between plants of different ploidy level. These may be grouped into the following three categories:

1. 4N PERENNIALS × ANNUALS. The following triploid hybrids have been secured: *H. decapetalus* × *annuus* (P338, H626), *H. decapetalus* × *debilis* ssp. *cucumerifolius* (H645d, DCDI), *H. decapetalus* × *debilis* ssp. *hirtus* (H649, H650), *H. hirsutus* × *annuus* (P339, H628), *H. hirsutus* × *debilis* ssp. *cucumerifolius* (H647), *H. strumosus* × *annuus* (P337, H626C).

These hybrids are rather difficult to secure and generally are more readily obtained with the tetraploid as the female parent. Vigorous triploids have been obtained in all combinations but weak and malformed plants are not uncommon. With the exception of the hybrid between *H. strumosus* and *H. annuus* all of the plants were winter killed when grown

out of doors but behaved as perennials in the greenhouse. Pollen fertility is usually quite low (1-15%) but one hybrid of *H. hirsutus* × *debilis* ssp. *cucumerifolius* gave a count of 64%. Most heads are absolutely barren. At meiosis the most commonly observed configuration is 17 pairs and 17 univalents (fig. 5) but considerable variation is encountered similar to that previously reported for *H. decapetalus* × *annuus* (Heiser and Smith 1960). Morphologically, the plants appear more nearly like the tetraploid parent but some influence of the annual parent can be detected. Triploid plants were treated with colchicine in two different years but no chromosome doubling occurred.

2. 6N PERENNIALS × ANNUALS. The only hybrid we have of this combination is between *H. tuberosus* × *annuus*. We have made this hybrid using two strains of *H. tuberosus* and four of *H. annuus* (H633Q, R, T, and S). Pollen stainability varies from 12 to 53% and the plants are mostly seed-sterile although an occasional filled achene is produced. The plants are all vigorous and overwinter in the field at Bloomington.

This hybrid has received considerable attention in Europe as a potential economic plant (Rudorf 1958) and the hybrid has been analyzed cytologically by Kostoff (1939). Our material has been unfavorable for detailed cytological study but we have made some studies of another hybrid (P194) supplied to us by the United States Department of Agriculture. In 20 cells studied a mean of 31 bivalents was found with the remainder of the chromosomes appearing as univalents or multivalents. These results agree fairly well with those of Kostoff. However, he observed bridges and fragments in his hybrid and in 50 cells of our material only a single bridge was seen at anaphase.

Other crosses involving an annual and a hexaploid species have been described by Wagner (1932) but he did not include cytological analyses and the identification of the parents of his hybrids is open to question.

3. PERENNIALS × PERENNIALS. Although several attempts

have been made by us, Long (1955), and Jackson (unpubl.) to secure crosses of diploid perennials with both the tetraploid and hexaploid species, no hybrids have been secured.

Various crosses between tetraploid and hexaploid species have been obtained, however. The initial cross gives very few seeds, but the resulting offspring are extremely vigorous. The hybrids secured and their fertility are as follows:

H. hirsutus 4*n* × *tuberosus* 6*n* (H452). 3 plants; pollen stainability 34 to 40%; seed set 10 to 20%.

H. smithii 4*n* × *strumosus* 6*n* (H570a + b). 8 plants; pollen stainability 83 to 99%; seed set 10 to 25%.

H. resinosus 6*n* × *decapetalus* 4*n* (H495). 1 plant; pollen stainability 62%; no seed set.

H. schweinitzii 6*n* × *smithii* 4*n* (H474b). 1 plant; pollen stainability 75%; seed set not known.

H. resinosus 6*n* × *smithii* 4*n* (K127b). 1 plant; pollen stainability 79%; no seed set.

H. decapetalus 4*n* × *resinosus* 6*n* (K183-5). 1 plant; no stainable pollen; no seed set.

Meiosis was examined in one or two plants of each combination. The number of pairs ranged from 31 to 34 with the remainder of the chromosomes appearing as univalents; 34 pairs and 17 univalents (Fig. 6) were observed in several cells.

ONE GENOME OR TWO?

Following Kostoff (1939) we have regarded *Helianthus* as having two distinct genomes. Our earlier work (1962) tended to support this assumption. Hybrids between diploid perennials and annuals are extremely difficult to secure and those that have been secured have been highly sterile and showed a highly irregular meiosis. In the hybrid, *H. canus* × *angustifolius*, several univalents were always observed and in the hybrid *H. debilis* × *floridanus* pairing was extremely variable although 17 pairs were observed in two cells (Heiser, Martin and Smith 1962). Recently hybrids have been secured between *H. niveus*, a member of the annual assemblage, and the perennials, *H. microcephalus*,

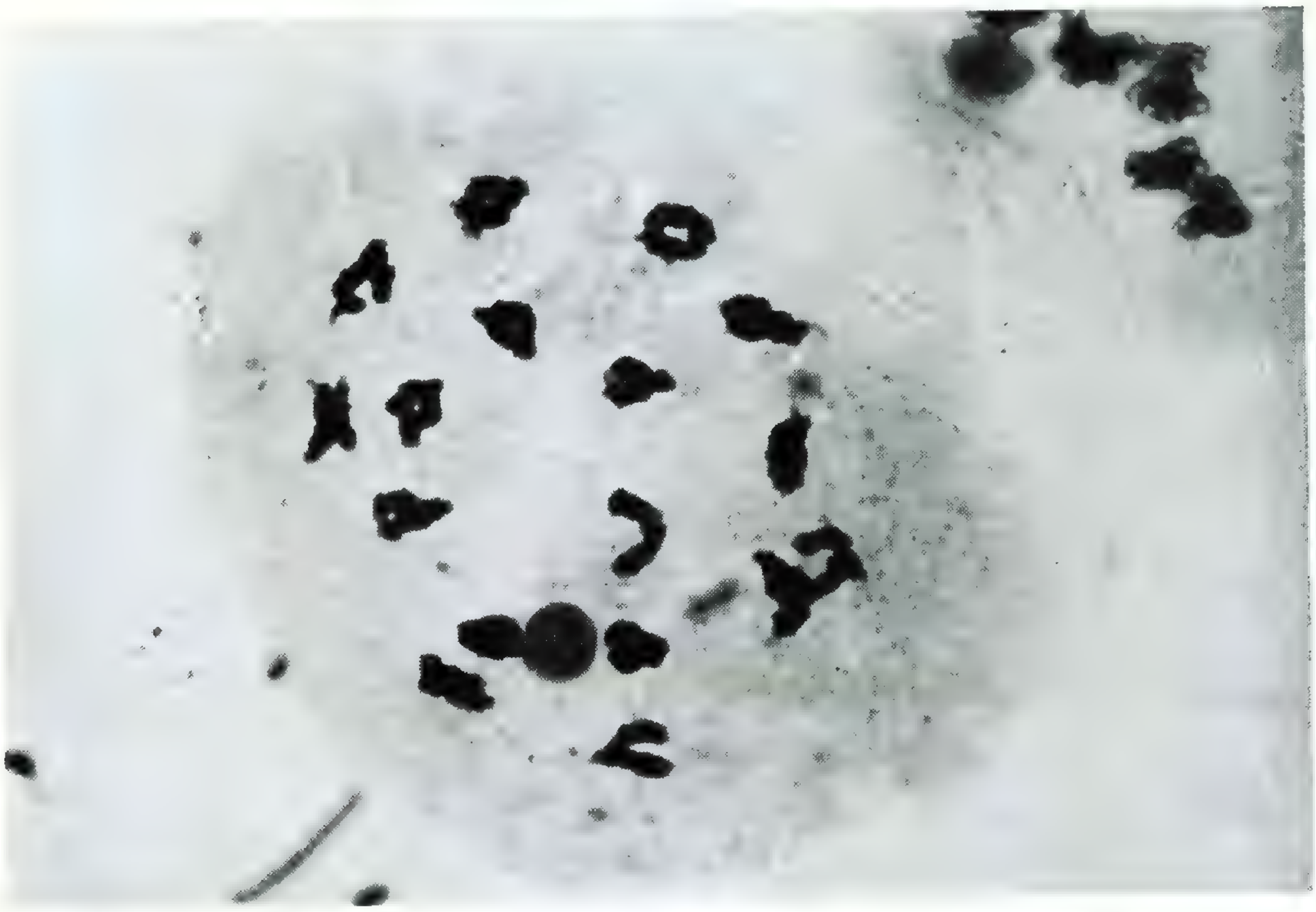

Fig. 7. Photograph of meiotic chromosomes in *Helianthus debilis* × *occidentalis* (H651), 17_{II}, × approx. 1300. Fig 7 is plate 13 [illegible]

H. nuttallii, and *H. occidentalis*, which although highly sterile (0-12% stainable pollen, and no seed set) show from 14 to 17 pairs at diakinesis. In the two hybrids secured between *H. debilis* and *H. occidentalis*, both highly sterile, one plant showed 17_{II} (Fig. 7) in 20 cells whereas the second plant had a highly irregular meiosis that did not lend itself to detailed analysis.

If, as we are assuming, the pairing in these annual-perennial hybrids is allosyndetic, and if one regards failure of pairing to be essential to the recognition of named genomes, then it indicates that we can not regard *Helianthus* as having distinct genomes. On the other hand, in view of the considerable genetic differentiation between the annual and perennial sunflowers and the sterility in the F_1 hybrids it might be desirable to continue to speak of A and B genomes in *Helianthus*

DISCUSSION

The data presented here and those published previously on hybridization in *Helianthus*, provide the basis for some

tentative conclusions about the interrelationships and probable mode of origin of the eastern North American polyploid species of the genus. It is doubtful that the cytogenetic study of other hybrid combinations will yield much more data than we now have because of the physical limitations imposed by the large number of chromosomes and the possibility of pairing between the chromosomes of the annual and perennial species. Other approaches, such as the use of chromosome morphology and chromatography (Smith & Levin, 1963), are definitely in order, but since such new studies may not yield relevant information for some time, it seems desirable to present our tentative conclusions about this group of sunflowers,

ORIGIN OF TETRAPLOIDS. It seems highly probable that the tetraploid species arose from eastern perennial diploids through allopolyploidy. The possibility that one of them, *H. decapetalus*, is an autopolyploid exists, although it may well be an allopolyploid (Smith 1960). Morphologically, the tetraploid perennials are very similar to many of the diploid perennials, for example *H. hirsutus* to *H. divaricatus*. Moreover, the few experimentally induced tetraploids show pairing very similar to that of naturally occurring tetraploids, and an apparently unreduced gamete of *H. decapetalus* functioned to produce a fertile tetraploid hybrid with *H. hirsutus*. Since it was shown in the previous paper of this series (Heiser *et al*, 1962) that the diploid hybrids display good chromosome pairing, the tetraploid species derived from them would be classed as segmental allopolyploids, following the classification of Stebbins (1950).

ORIGIN OF THE HEXAPLOIDS. On the basis of the chromosome pairing relations in the hybrid *H. tuberosus* × *annuus*, Kostoff (1939) suggested a genomic formula of $A_t^1A_t^1A_t^2$-$A_t^2B_tB_t$ for *H. tuberosus* and postulated that the B_t genome was similar to that of *H. annuus*. Since all the eastern hexaploid perennials give largely fertile hybrids with fairly good chromosome pairing it seems possible that all of them may have a similar genomic make-up. There can be little doubt that two genomes (the A genomes of Kostoff) of the

hexaploids come from the tetraploid perennials. This is suggested not only in the results secured from the crossing of tetraploids and hexaploids but also on morphological grounds; *Helianthus strumosus*, for example, exists as both a tetraploid and a hexaploid.

Our problem then concerns the source of the third genome (the B genome of Kostoff). Our data from the analysis of triploids in which we frequently find 17 pairs and 17 univalents might be used to support Kostoff's claim if we postulate pairing of the perennial genomes and univalent formation from the annual genome. Such hybrids, if doubled, would produce hexaploids. On the basis of their present distribution it seems unlikely, however, that any of the annual species could represent one of the progenitors. *Helianthus annuus* is the only species that is sympatric with the majority of the tetraploids and hexaploids and it is probable that it was introduced into the eastern United States in recent times by man (Heiser 1955). If an annual genome is represented we would have to postulate that its combination with the A genome must have occurred at some time when the distributions of the species were quite different from that seen today.

Morphologically, our studies thus far have shown no indication of the annual sunflowers in the hexaploid species, with the possible exception of the large size of certain characters in cultivated forms of *H. tuberosus*, and it is quite possible that this increased size could have come about through artificial selection by man. Although we might expect that the two genomes of perennial sunflowers might effectively mask any feature supplied by the annual genomes, it must be admitted that the influence of the annual can be detected in the triploids. However, the very fact that triploid hybrids can be secured between perennials and annuals, whereas perennial diploid × tetraploid hybrids have not been secured, may be significant. So far, however, it has been impossible to secure doubling in any of the triploids.

The possibility that the hexaploids may have had their origin entirely from the eastern perennials, which would be

more reasonable in light of the present geographical distribution of the species concerned, deserves serious consideration. It has already been pointed out that this could be justified on morphological grounds. The 34 pairs and 17 univalents resulting in the crosses between the hexaploid and tetraploid perennials also do not rule out this possibility. If the parental gametes were $A_1A_2A_3$ and A_1A_2 — where the subscripts represent genomes of different diploid perennials — we might expect such pairing rather than the formation of trivalents. The pairing observed in the *H. tuberosus* × *annuus* plant also would not necessarily negate this hypothesis. If, for example, *H. tuberosus* is $A_1A_2A_3$ or perhaps $A_1A_1A_3$ we might expect pairing of A_1 with A_2 or A_1 with A_1 and pairing of A_3 with the B genome of *H. annuus*. Here again critical crosses that would give evidence of this have not been secured. However, in the diploid perennial × diploid annual hybrids now known, up to 17 bivalents are not uncommon, indicating that pairing can occur between the chromosomes of the annuals and perennials.

Although some evidence on the origin of the hexaploids might be provided by securing hybrids between diploid and tetraploid perennials, it seems unlikely that genomic analysis can provide critical evidence on the origin of the hexaploids. The question of the origin of the third genome therefore must remain open until additional lines of investigation are pursued.

TAXONOMIC SIGNIFICANCE. The bearing of polyploidy on the species problem has already been discussed for the tetraploids (Smith 1961) and these remarks apply equally well to the hexaploids. It is the polyploid species that have given the genus the reputation of being taxonomically difficult. The diploid species, in spite of rather extensive inter-specific hybridization, offer far fewer taxonomic problems. Whether one species, a few species, or many species are recognized in the polyploids is largely a matter of personal choice. We follow the second course and in so doing reflect the opinions of most taxonomists, excepting Watson (1929), who recognized many species in this complex. Even so, it means that

there will remain many specimens that will have to be placed somewhat arbitrarily in one or the other species. Thus, while we have not made the species any "easier" to identify, we have shown some reasons for the taxonomic difficulties inherent in this polyploid complex.

SUMMARY

Twenty-five new artificial hybrids involving polyploid species are reported. The five tetraploid species of the eastern United States have been connected by a series of hybrids. These hybrids are generally fertile and show fairly regular chromosome pairing. A similar situation holds for the five hexaploid taxa of the same area. Several heteroploid hybrids are reported and their chromosome pairing discussed. Four colchicine-induced tetraploid perennials have been obtained which are cytologically similar to the naturally occurring tetraploids. It is concluded that the tetraploid perennials of the eastern United States are either segmental allopolyploids or autopolyploids derived from the eastern perennial diploids. The hexaploids in all probability have two genomes from these tetraploids. Although Kostoff's suggestion that the third genome of the hexaploids comes from a sunflower similar to *Helianthus annuus* cannot yet be ruled out, it appears possible on morphological and geographical grounds that the third genome was supplied by the eastern perennials. In view of the fact that several hybrids have been secured between diploid annuals and perennials which exhibit good pairing, genomic analysis fails to supply critical evidence bearing on the origin of the hexaploids. It is pointed out that the analysis of the hybrids helps explain the complicated taxonomic situation existing in the polyploid species.

INDIANA UNIVERSITY AND UNIVERSITY OF ILLINOIS

LITERATURE CITED

CLEVENGER, SARAH, AND C. B. HEISER. 1963. *Helianthus laetiflorus* and *Helianthus rigidus* — hybrids or species? Rhodora **65**:121-133.

DARLINGTON, C. D. 1956. Chromosome botany. Allen and Unwin, London. 186 p.

HEISER, C. B. 1954. Variation and subspeciation in the common sunflower, *Helianthus annuus*. Amer. Midl. Nat. **51**: 287-305.

———————, 1961. Morphological and cytological variation in *Helianthus petiolaris* with notes on related species. Evolution **15**: 247-258.

———————, AND D. M. SMITH. 1960. The origin of *Helianthus multiflorus*. Amer. Jour. Bot. **47**: 860-865.

———————, WM. MARTIN AND D. M. SMITH. 1962. Species crosses in *Helianthus:* I. diploid species. Brittonia **14**: 137-147.

JONES, G. N. 1963. Flora of Illinois, 3rd ed. Amer. Midl. Nat. Monog. 7. University of Notre Dame Press. 401 p.

———————, AND G. D. FULLER. 1955. Vascular plants of Illinois. U. of Ill. Press. 593 p.

KOSTOFF, D. 1939. Autosyndesis and structural hybridity in F_1 hybrid *Helianthus tuberosus* L. × H. *annuus* L. and their sequences. Genetica **21**: 285-300.

LONG, R. L. 1955. Hybridization in perennial sunflowers. Amer. Jour. Bot. **42**: 769-777.

RUDORF, WILHELM 1958. Topinambur, *Helianthus tuberosus* L. Handbh. der Pflanzenzuchtung **3**: 327-341.

SMITH, D. M. 1960. The chromosome number of *Helianthus decapetalus*. Trans. Ky. Acad. Sci. **21**: 17-19.

———————, 1961. Variation in the tetraploid sunflowers, *Helianthus decapetalus*, H. *hirsutus* and H. *strumosus*. Recent Advances in Botany 1: 878-881. U. of Toronto Press.

———————, AND D. A. LEVIN. 1963. A chromatographic study of reticulate evolution in the Appalachian *Asplenium* complex. Amer. Journ. Bot. **50**: 952-958.

STEBBINS, G. L. 1950. Variation and evolution in plants. Columbia University Press, N. Y.

WAGNER, S. 1932. Artkreuzungen in der gattung *Helianthus*. Zeit. Indukt. Abst. u. Vererb. **61**: 76-146.

WATSON, E. E. 1929. Contributions to a monograph of the genus *Helianthus*. Pap. Mich. Acad. **9**: 305-475.

GENETIC BARRIERS IN THE COSMANTHUS PHACELIAS (HYDROPHYLLACEAE)[1]

GEORGE W. GILLETT

The Cosmanthus phacelias occur in North America from Guatemala to New York State and total 14 recognized species (Constance, 1949). Eleven of these occur northeast of the Texas Gulf Coast over an extensive region in which no other phacelias are indigenous. This group, therefore, has a notable degree of geographic unity.

The appearance of additional work on the Cosmanthus phacelias might seem redundant to those who recall the revisions accorded them by Gray (1875), Brand (1913), and Constance (op. cit.). However, the last revision was followed by a paper (Constance, 1950) that stressed three putative hybrid phylogenies within six species of the group and urged their investigation by breeding experiments. The current paper presents and summarizes a crossing program carried out with these six species and four additional ones in the Cosmanthus group.

The chromosome number is known for thirteen of the fourteen species in this group (Cave and Constance, 1947, 1950). Of the ten species in the crossing program, eight, *Phacelia fimbriata* Michx., *P. gilioides* Brand, *P. hirsuta* Nutt., *P. laxa* Small, *P. patuliflora* (Engelm. & Gray) A. Gray, *P. platycarpa* (Cav.) Spreng., *P. purshii* Buckl., and *P. strictiflora* (Engelm. & Gray) A. Gray, are characterized by nine pairs of chromosomes. Two species, *P. dubia* (*L*). Trel.; and *P. maculata* Wood, have five pairs.

The four excluded species are: *Phacelia bipinnatifida* Michx.; *P. glabra* Nutt.; *P. pulcherrima* Const.; and *P. ranunculacea* (Nutt.) Const. Each is a very distinct taxon. *Phacelia bipinnatifida* has the not-unusual chromosome complement of nine pairs, but a disparity in chromosome number is noted for *P. glabra* (8 pairs) and *P. ranunculacea* (14

[1]Aided by grants from the National Science Foundation.

pairs). No chromosome information is available for *P. pulcherrima*, a comparatively rare Mexican endemic.

Plants of the following races were grown from seed in the greenhouse at East Lansing. Races of *Phacelia hirsuta*, *P. gilioides*, *P. strictiflora*, *P. patuliflora*, *P. dubia*, and *P. maculata* were also grown at Turku, Finland.

Species	*Seed Locality*	*Documented by*[2]
P. strictiflora	Dallas Co., Texas	*Gillett 1257*
P. patuliflora	San Patricio Co., Texas	*Gillett 1216*
P. laxa	San Patricio Co., Texas	*Gillett 1217*
P. platycarpa	Volcan Tacana, Guatemala	*Beaman 3200*
	Nevada de Toluca, Mexico	*Gillett 1252*
P. hirsuta	Washington Co., Arkansas	*Gillett 1215*
P. gilioides	Osage Co., Missouri	*Gillett 1260*
P. purshii	Sevier Co., Tennessee	*Gillett 1214*
	Butler Co., Ohio	*Gillett 1203*
P. fimbriata	Swain Co., North Carolina	*Gillett 1207*
	Sevier Co., Tennessee	*Gillett 1213*
P. maculata	Lancaster Co., South Carolina	*Gillett 1208*
P. dubia	Dare Co., North Carolina	*Gillett 1262*

Some species of *Phacelia* are protandrous (with the anthers dehiscing before the stigmas are receptive), so that a seed-set is rarely obtained by pollinating newly-opened flowers. Consequently, flowers of proposed ovulate parents were emasculated just before anther dehiscence, labeled with a jeweler's tag, and pollinated two days later. Self-pollinations by this method produce viable seed in all species, so that the experimental cross-pollinations provide reliable tests of genetic compatibility. Stigmas were examined by a 15 × hand lens to verify their freedom from contaminating pollen before experimental cross-pollinations were made.

Capsules from cross-pollinated flowers were harvested at dehiscence and placed in storage for approximately three months. Products from a given cross, including seeds with obviously retarded development, were then placed on stand-

[2]Voucher specimens deposited at the Herbarium of the University of California, Berkeley.

ard germination paper in a petri dish and moistened with 0.2% KNO_3, a solution that produces favorable germination in these species. Petri dishes were covered and placed in a growth chamber with alternating periods of 20° centigrade (16 hours) 30° (8 hours). Upon germination, seedlings were planted in a mixture of equal parts of screened sand and peat in 3-inch clay pots. These were watered from below until cotyledons emerged and expanded.

All of the species were studied in native habitats, and the variability of each species was studied by the examination of several hundred herbarium specimens.[3]

The comparative morphology of seeds and glandular trichomes has provided helpful guides to evolutionary relationships in *Phacelia* (Gillett, 1960), so that it was appropriate to study the seeds and trichomes of the Cosmanthus group. Seed morphology, including seed size and shape, seed coat sculpturing, and embryo form and size, was determined for all species. Glandular trichromes were studied from whole mounts of living material.

All these species are self-fertile, and all are outcrossers except *Phacelia purshii* which is self-pollinated. The results of breeding experiments are presented in Table 1, the data summarized in terms of the number of ovules tested in the seed parents. The number of seeds produced by self-pollinated flowers of the seed parent was taken as a reasonably conservative approximation of the number of ovules available for cross-fertilization. The number of seeds per capsule was determined as the median complement of seeds from 5 to 30 capsules.

The experimental crosses were made to determine genetic affinities and to test channels of potential gene flow among the 10 species in the group. All 45 potential channels have

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[3]Appreciation is extended to herbarium curators at the Chicago Natural History Museum; Gray Herbarium of Harvard University; Michigan State University; Missouri Botanical Garden; New York Botanic Garden; Smithsonian Institution; University of California, Berkeley; University of Michigan; University of Texas; and the University of Wisconsin for making herbarium specimens available for this study.

been tested, 39 of these by reciprocal crosses. Of the possible combinations, only the one between *Phacelia hirsuta* and *P. gilioides* was found conclusively to permit gene flow. Fertile F_1 and F_2 hybrids were obtained from this cross. It must be emphasized that the genetic barriers indicated in Table 1 are relative and not necessarily absolute. They may restrict gene flow, but may not be capable of stopping it completely, especially if large numbers of flowers are cross-pollinated in the natural habitat.

Seed morphology contributes significant evidence of relationships in this group. The uniformly larger, keeled seeds of *Phacelia fimbriata* and *P. purshii* are consistently distinguishable from the much smaller, angular to ovoid seeds of the other species in the group. The uniformly larger seeds of *P. fimbriata* are distinguishable from those of *P. purshii* in mixed samples.

The remaining eight species can be classified into two groups on the basis of seed characters: those species in which the seed coat sculpturing is registered on the endosperm (recognizable with a hand lens), including *Phacelia patuliflora*, *P. strictiflora*, and *P. laxa;* and those species in which the seed coat sculpturing is *not* registered on the endosperm, including *P. platycarpa*, *P. dubia*, *P. maculata*, *P. gilioides*, and *P. hirsuta*. The seeds of *P. patuliflora*, *P. strictiflora* and *P. laxa* are similar in size, shape (angular to ovoid), and seed coat design (Fig. 1, a, b). These three species have a common chromosome number, occur in the same region, and have other morphological similarities that suggest a common evolutionary line. In the second group, seeds of *P. platycarpa* are distinguished by a relatively large embryo, over 1 mm. long (Fig. 1, h). Seeds of the remaining four species *P. dubia*, *P. maculata*, *P. gilioides*, and *P. hirsuta* are remarkably similar in size, shape (angular), seed coat design, and embryo morphology (Fig. 1, c, d, j, k). However, the disparity in chromosome number between *P. dubia* and *P. maculata* ($n = 5$), on the one hand, and *P. gilioides* and *P. hirsuta* ($n = 9$), on the other, suggests that these similarities in seed are expressions of parallel evolution in two distinct lines.

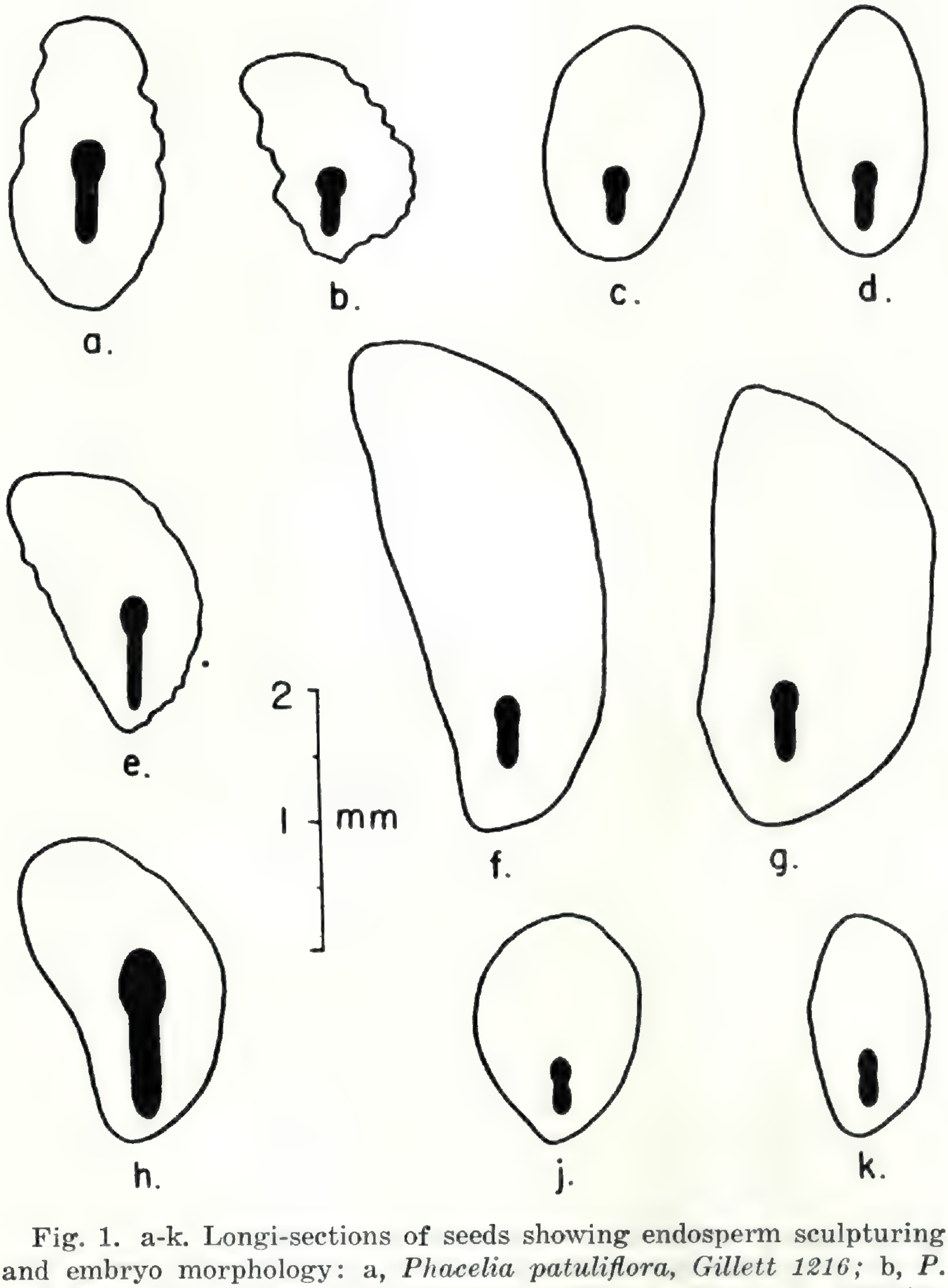

Fig. 1. a-k. Longi-sections of seeds showing endosperm sculpturing and embryo morphology: a, *Phacelia patuliflora, Gillett 1216;* b, *P. strictiflora, Gillett 1257;* c, *P. hirsuta, Gillett 1215;* d, *P. gilioides, Gillett 1260;* e, *P. laxa, Gillett 1217;* f, *P. fimbriata, Gillett 1207;* g, *P. purshii, Gillett 1214;* h, *P. platycarpa, Beaman 3200;* j, *P. maculata, Gillett 1208;* and k, *P. dubia, Gillett 1262.*

The glandular trichomes, or colleters, of all ten species are characterized by unicellular heads and uniseriate stalks, a type found in several other phacelias.

Field studies and the examination of extensive herbarium collections have provided supporting evidence for most of the genetic barriers indicated in the crossing program. Six of these species, including *Phacelia dubia*, *P. fimbriata*, *P. laxa*, *P. maculata*, *P. platycarpa*, and *P. purshii*, are in each instance distinct from other phacelias. While each of these has its own range of variability, I have found no indication that this is caused by hybridization with any other species.

Intermediates between *Phacelia gilioides* and *P. hirsuta* occur frequently in nature, and have been produced from experimental crosses. Variability of the natural hybrids is so extensive as to effect a complete intergradation between the two species. In nature, these portray a single, genetically isolated complex.

The two remaining species, *Phacelia patuliflora* and *P. strictiflora*, also blend into each other through intergrading forms. These is evidence, therefore, that natural hybridization has occurred between these species even though it was not possible to secure experimental hybrids. This suggests that the internal genetic barrier is relatively weak and is easily bridged when sufficient numbers of flowers are cross-pollinated in nature. These two intergrading species also appear to constitute a genetically isolated complex.

The three hybrid phylogenies cited by Constance (1950) are listed below.

PARENT	PUTATIVE HYBRID	PARENT
1. *P. strictiflora* var. *lundelliana*	*P. strictiflora* var. *robbinsii*	*P. hirsuta*
2. *P. patuliflora* var. *teucriifolia*	*P. patuliflora* var. *patuliflora*	*P. laxa*
3. *P. hirsuta*	*P. gilioides*	*P. purshii*

The first problem cited above involves variable and intergrading races of *Phacelia strictiflora*. The race of *P. strictiflora* grown in this study would correspond more nearly to

var. *lundelliana*. No hybrids were obtained in the limited crosses between this material and *P. hirsuta* seed parent, and studies of herbarium material revealed no natural hybrids between *P. strictiflora* and *P. hirsuta*. Several herbarium collections include mature seed. Variability in seed structure in no way suggests gene flow into *P. strictiflora* from *P. hirsuta*, or in the reverse direction. Seed differences between these two species are qualitative rather than quantitative. A similar qualitative difference is noted in the calyx whch is accrescent in *P. strictiflora* and non-accrescent in *P. hirsuta*. In summary, the results of this study indicate that *P. hirsuta* has not contributed genes to the highly variable *P. strictiflora*.

The second problem involves highly variable and intergrading races of *Phacelia patuliflora*. The race of *P. patuliflora* grown in this study would correspond most nearly to var. *patuliflora*. Extensive crosses from *P. laxa* to the *P. patuliflora* seed parent produced no hybrids, and sufficient ovules were tested to have revealed a very low compatibility, if such exists. Therefore, a relatively effective genetic barrier is indicated between the putative hybrid (*P. patuliflora* var. *patuliflora*) and one of its proposed parents (*P. laxa*). *Phacelia laxa* is sympatric with *P. patuliflora*, its distribution falling entirely within the range of the latter, and populations of the two species grow in close proximity in nature. However, I was unable to detect natural hybrids in herbarium material. Ecological, morphological, and genetical differences between these species would indicate that they have evolved independently of each other for some time.

The proposed hybrid origin of *Phacelia gilioides*, with *P. hirsuta* and *P. purshii* as parental lines, is strongly suggested by corolla morphology for the crenulate-fimbriate corollas of *P. gilioides* seem clearly intermediate between the entire corollas of *P. hirsuta* and the strongly fimbriate corollas of *P. purshii*. However, the study of several differences, including seed characters, long-recognized to be among the most conservative in *Phacelia*, revealed qualitative differences between *P. purshii*, on the one hand, and *P. gilioides*

Table 1. Summary of cross-pollinations in 10 species of the Cosmanthus phacelias. Tabular figures are the number of ovules tested in the seed parents. This is approximated for each cross by multiplying the median number of seeds in selfed capsules (figures to the right of seed parents) by the number of flowers cross-pollinated. Crosses with asterisk produced hybrids.

Races of *Phacelia platycarpa*, *P. purshii*, and *P. fimbriata* are *Beaman 3200*, *Gillett 1214*, and *Gillett 1213*, respectively.

	POLLEN PARENT									
	$n = 9$						$n = 5$			
SEED PARENT	*strictiflora*	*patuliflora*	*laxa*	*platycarpa*	*hirsuta*	*gilioides*	*purshii*	*fimbriata*	*maculata*	*dubia*
strictiflora (7)	—	14	7	0	0	0	0	0	0	7
patuliflora (11)	22	—	396	33	22	22	22	22	44	22
laxa (6)	12	54	—	18	6	6	12	12	24	6
platycarpa (3)	6	6	6	—	6	6	6	6	6	6
hirsuta (7)	28	14	14	21	—	28*	63	14	14	14
gilioides (5)	15	10	10	10	50*	—	20	15	10	10
purshii (4)	20	8	8	8	36	20	—	20	8	8
fimbriata (4)	12	8	8	12	16	12	20	—	8	8
maculata (7)	14	28	42	14	14	28	21	21	—	84
dubia (5)	10	15	20	10	20	10	10	10	85	—

and *P. hirsuta* on the other. These qualitative differences are correlated with experimentally demonstrated internal genetic barriers. Additional evidence of the genetic integrity of *P. purshii* is seen in its inbreeding system which tends to reinforce, rather than to overcome, the internal genetic barrier. The study of herbarium material and of populations in nature has produced no evidence that the variability of *P. purshii* is caused by gene flow from *P. gilioides*, or that the variability of *P. gilioides* and *P. hirsuta* is related to gene flow from *P. purshii*. Available evidence suggests that *P. purshii* is in a distinct evolutionary line and that *P. gilioides* and *P. hirsuta* constitute another.

Crossing programs completed on 23 diploid species of *Phacelia*, involving at least five major evolutionary lines (Sections WHITLAVIA and GYMNOBYTHUS, the *P. franklinii* group, *P. linearis* (a monotypic line), and the Cosmanthus group) indicate that speciation in this genus usually involves an internal genetic barrier. Where no internal genetic barrier has evolved, other barriers are relatively weak, always permitting crossing in nature, presumably through the inconstant behavior of insect pollinators. Where taxonomic problems occur in these five groups (and there have been five such cases), they have been traceable to natural hybridization.

ACKNOWLEDGEMENTS

This research was initiated at Michigan State University and was completed at the Department of Botany, University of Turku, Finland, under a Fulbright Lectureship. Grateful appreciation is extended to Professor Antero Vaarama for his generous provision of space and facilities and for the many kindnesses extended by Dr. Reino Alava and other members of the staff at Turku. Seed collections were obtained through the generous assistance of Edgar Anderson, Ritchie Bell, Albert Clebsch, Philip Crutchfield, Fred Jones, Dwight Moore, Neil Reid, Royal Shanks, Lloyd Shinners, and Ben Williamson.

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LITERATURE CITED

BRAND, A. 1913. Hydrophyllaceae. *In* A. Engler, Pflanzenreich 4251: 1-210.

CAVE, M. S., AND L. CONSTANCE. 1947, 1950. Chromosome numbers in the Hydrophyllaceae. Univ. Calif. Publ. Bot. **18:** 449-465. **23:** 363-382.

CONSTANCE, L. 1949. A revision of *Phacelia* subgenus Cosmanthus (Hydrophyllaceae). Contr. Gray Herb. **168:** 1-48.

———. 1950. Some interspecific relationships in *Phacelia*, subgenus Cosmanthus. Proc. Am. Acad. **78:**135-147.

GILLETT, G. W. 1960. A systematic treatment of the *Phacelia franklinii* group. Rhodora **62:** 205-222.

GRAY, A. 1875. A conspectus of the North American Hydrophyllaceae. Proc. Am. Acad. **10:** 312-332.

CHROMOSOME COUNTS FOR PASPALUM[1]

DONALD J. BANKS

I have made some additional chromosome counts during my studies in the genus *Paspalum*. None of the counts for the taxa reported herein, except *P. laeve*, are recorded in the Chromosome Atlas (Darlington and Wylie, 1955) or in the Index to Plant Chromosome Numbers (Cave, 1956-1962). My counts of $n = 40$ for *P. laeve* are different from $2n = 40$ which was reported by Brown (1948).

The counts were made from pollen mother cells squashed in aceto-carmine after fixation in alcohol-acetic acid (3:1). Photomicrographs were made of cells with chromosomes distributed so that they were countable. Drawings, made by tracing enlargements of the photomicrographs, are presented in Figures 1-5.

[1]Contribution No. 55 from the Stephen F. Austin State College Department of Biology. Part of this work was done at the University of Texas Department of Botany while I was a National Science Foundation research participant during the summer of 1963. Thanks are due Dr. W. V. Brown for providing facilities during the research period.

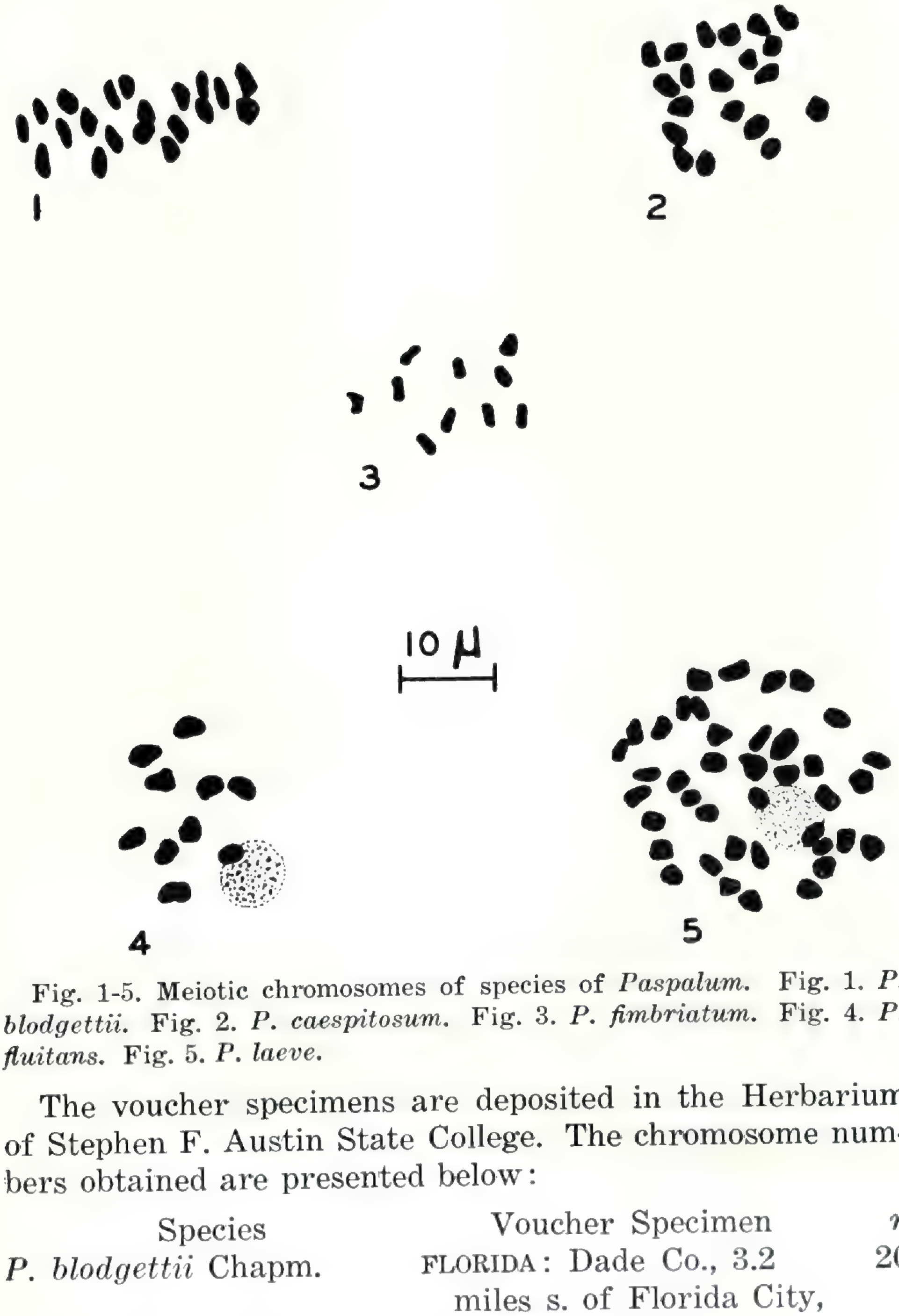

Fig. 1-5. Meiotic chromosomes of species of *Paspalum*. Fig. 1. *P. blodgettii*. Fig. 2. *P. caespitosum*. Fig. 3. *P. fimbriatum*. Fig. 4. *P. fluitans*. Fig. 5. *P. laeve*.

The voucher specimens are deposited in the Herbarium of Stephen F. Austin State College. The chromosome numbers obtained are presented below:

Species	Voucher Specimen	*n*
P. blodgettii Chapm.	FLORIDA: Dade Co., 3.2 miles s. of Florida City, *Banks 1246*	20
P. caespitosum Flügge	FLORIDA: Collier Co., 6 miles n. of Rock Island, *Banks 1198*	20

P. fimbriatum H. B. K.	FLORIDA: Monroe Co., Plantation Key, *Banks 1223*	10
P. fluitans (Ell.) Kunth	TEXAS: Nacogdoches Co., 5 miles s. and 7.2 miles e. of Cushing, *Banks 1910*	10
P. laeve Michx.	GEORGIA: Clarke Co., Athens, *Banks 1053*	40
	TEXAS: Nacogdoches Co., Stephen F. Austin Experimental Forest, *Banks, 1913*	40

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LITERATURE CITED

BROWN, W. V. 1948. A cytological study in the *Gramineae*. Am. Jour. Bot. 35:382-395.

CAVE, M. S. (Editor). 1956-1962. Index to plant chromosome numbers. The University of North Carolina Press. Chapel Hill, North Carolina.

DARLINGTON, C. D. AND A. P. WYLIE. 1955. Chromosome atlas of flowering plants. George Allen and Unwin Ltd. London.

SOME OBSERVATIONS ON THE DISSEMINATION OF TRIPSACUM

WALTON C. GALINAT AND FRANK C. CRAIGHEAD

The observations reported here on the dissemination of *Tripsacum* are the results of a continuing attempt to uncover more information on this grass which might shed additional light on its evolutionary relationship with maize. In particular, we were interested in *Tripsacum floridanum* because it has certain features which are primitive for the genus. It is endemic to south Florida and crosses more easily with maize than do most other species of *Tripsacum* (Galinat, 1961). Since our previous collections of *T. floridanum* had all been from Dade County and chiefly in the Everglades National Park, we set out to botanize for this grass in Collier County, an area of greater geological age than that of Dade County.

On our trip westward along the Tamiami Trail in Collier County, we were able to make our first observations. They suggested water as a factor in the spread of *Tripsacum*. The relationship between the highway and a canal along one side, created by the road construction technique used in south Florida, made possible these observations. While we were driving westward, the canal lay on our side of the highway and, after a few checks for accuracy, we began to count colonies of *T. dactyloides*, while traveling at a speed of at least 40 miles per hour, slower speeds being hazardous on this highway. The characteristic clumps of plants with arching, rather broad grass leaves together with scattered tall flowering canes bearing tassel-like inflorescences enabled us to identify this plant with ease and rapidity. In one 25 mile long strip, we observed in this manner about 25 colonies of *Tripsacum*. On the return trip along the same length of highway but on the other side which lacked an abutting canal, we observed only one colony of *Tripsacum*. It seemed possible that flotation along the canal, perhaps during periods of high water, had a role in spreading the

Tripsacum on the canal side and, thereby, resulted in its higher frequency there.

Other observations suggesting that water is involved in the spread of *Tripsacum* came from the distribution of *T. floridanum*, the prime object of our trip to Collier County. This species is most frequently located at the margin of the slightly higher limestone where it protrudes into the marl land which characterizes the glades. It would seem that the *Tripsacum* fruit cases float across the usually flooded glades and become established on the out-cropping of limestone which forms pine hammocks. The *Tripsacum* usually does not migrate far into the pine land from its beach head, unless the undergrowth, such as saw palmetto, is sparse, and unless the canopy is sufficiently open to permit penetration of diffuse to full sunlight.

With these field observations in mind, we went to the laboratory and readily demonstrated that the mature grain-bearing fruit cases of *Tripsacum* did, indeed, have this essential capacity to float on water. In this experiment, thirty-three fruit cases were spilled out into a beaker full of water. They immediately began to float, and during the following week only about a quarter of them sank, as shown in Table I.

Table I. The floating capacity of mature fruit cases of *Tripsacum dactyloides*.

Days on water	Percent floating
0	100
1	94
2	85
3	82
4	76
5	73
6	73

Slight differences in the tightness with which the cupule wings clasped the outer glume of the enclosed spikelet, differences in the density of hairs in the pulvinus notch through which water may enter and differences in the shape and thickness of the rachis segment appear to have affected the floating capacity of the fruit cases. If we assume that

a good floating capacity had some selective advantage as a means of dispersal, then the structure of the fruit cases may have been altered along these lines.

We have also made a few observations on factors other than water which seem to be involved in the spread of *Tripsacum*. During the few stops that we made along the Tamiami Trail drive, we noted that the seasonal mowing of the banks by the State Highway Department seemed to stretch the colonies out, as if by dragging from the mowers moving parallel to the banks. This mowing, furthermore, seemed to aid the growth of *Tripsacum* by temporarily eliminating competition for light by other plants which made a slower recovery from being cut back.

Fire, like the mowing, likewise seems to be important in keeping an area sufficiently open for *Tripsacum*, at least in the case of *T. floridanum* on pine land. The rhizomes of *T. floridanum* are fairly fire-resistant and a regrowth of its shoots is frequently the first sign of green in a fire-blackened area. The numerous, tightly packed leaf bases of *Tripsacum* usually protect the growing points on the rhizomes from destruction by fire. Furthermore, the burning off of some of the mass of dead, usually wet, leaf bases seems to stimulate new growth from the axillary buds. The sprouting of these buds may stem from both the physical removal of enclosing dead tissue as well as the removal of an unfavorable chemical environment immediately around the growing points.

Another most interesting means of dispersal of *Tripsacum* came to light in a story related to us by a farmer, Mr. Glenn Simmons. Mr. Simmons was quite familiar with *T. floridanum*, in that a large growth of it occurs in the pines around his farm. He said that the local inhabitants frequently carried a pocket full of the fruit cases to chew when out on hunting trips in the Everglades. The fully matured *Tripsacum* fruit cases which are much too hard to chew were sometimes cracked open with the teeth and the grain shelled out for eating. But if the mature fruit cases were either swallowed whole or just discarded to the ground, they

might became effectively dispersed. At least in the case of teosinte, Garrison Wilkes (unpub.) reports that cattle do pass the fruit cases through the digestive tract and that the seed recovered from the manure remains viable. Man is known to have chewed teosinte for a considerable period of time. The senior author has identified fragments of a teosinte fruit case in human coprolites from Romero's Cave in Tamaulipas, carbon-dated at 3650±250 years (E. O. Callen, personal communication).

The possibility that birds such as ducks may be involved in the dispersal of *Tripsacum* has also been considered. Experiments are contemplated for testing this by feeding *Tripsacum* fruit cases to chickens or domestic ducks and then spreading the recovered dung out on the ground where any viable fruit cases may germinate.

In the case of teosinte, the indigo bunting, certain grosbeaks and sparrows in Guatemala consume the seed by shelling it out of the fruit case. The result is a complete digestion and destruction of the seed (Stadelman, 1939).

Isolated plants and small colonies of *Tripsacum* are occasionally found far removed from presently existing glades or other water sources. These exceptional plants may have been transported to such places by other means or else they may represent relic survivors from ancient distributional patterns.

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LITERATURE CITED

GALINAT, W. C. 1961. *Tripsacum floridanum* crosses readily with corn. Maize Genetics Coop. News Letter **35**: 38-39.

STADELMAN, R. 1939. Consumption of teosinte seed by birds in Guatemala. Science **89**: 461-462.

FLORISTIC CHANGES WITHIN PITCHER PLANT HABITATS IN GEORGIA[1]

THOMAS PULLEN, JR., AND GAYTHER L. PLUMMER[2]

About the turn of this century Harper (1906) recognized that nearly one-fourth of the flora within the Altamaha Grit Region consisted of species characteristic of the moist pine barrens. These lowland habitats were mostly occupied by cypress *(Taxodium ascendens)*, pines *(Pinus elliottii)* and *P. serotina*) and mixed shrubs along with many insectivorous plants, particularly, *Sarracenia, Drosera, Pinguicula,* and *Utricularia.*

This study indicates some of the floristic changes that have occurred in the moist barrens within the past fifty years by comparing the list of 1906 with that made in 1962. Furthermore, some suggestions are offered that may explain observed differences in these lists.

Early soil survey reports (Sweet and Tillman, 1918; Moon, 1928) indicated that pitcher plant habitats were of rather low quality and that they were best used as forests or as unimproved pastures. Later reports (Phillips, *et al.*, 1928; Beesley, 1948) point out that many of these lands could be improved for agricultural purposes by clearing the trees and undergrowth, and by draining the excess water. Modern land management has greatly altered habitats in that many have been cleared, drained and burned annually for intensified grazing on native grasses. Nevertheless, these habitats remain without applications of inorganic fertilizers. Other habitats remain apparently undisturbed for intervals of ten to twenty years, altered only by fire, selective logging, or the collection of pine sap for turpentine.

Places and Procedures

Specimens of plants in flower were collected monthly between April 21, 1962, and October 7, 1962, at seven moist

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pine barrens throughout the Middle Coastal Plain region. Many non-flowering plants were collected also. Specimens are on file in the University of Georgia herbarium. Collection sites were located in:

Emanuel County.	1.5 mi. s. Oak Park on w. side of U. S. highway 1. Plummer soil series.
Toombs County.	3 mi. e. of railroad depot in Lyons. Plummer soil series.
Toombs County.	2.5 mi. n. of court house in Lyons. Myatt soil series.
Wheeler County.	2 mi. w. of Alamo on Ga. highway 30. Plummer soil series.
Irwin County.	Intersection of Irwin and Ben Hill counties at U. S. highway 129. Plummer soil series.
Tift County.	2.5 miles w. Alapaha River that intersects with Tift and Berrien counties. Rains soil series.
Bullock County.	4 mi. s. Statesboro on w. side Ga. highway 67. Plummer soil series.

All soils are loamy fine sands and for practical purposes the differences between the series are chiefly morphogenetical (Plummer, 1963).

The authors acknowledge the assistance of Dr. Wilbur H. Duncan, and specialists Donald Banks, Samuel B. Jones, and Don Blake for aid in identification of specimens.

Results and Discussion

Harper reported 187 species in the moist pine barrens, and estimated the list to be about 75 per cent of the total flora. The list included three species of trees, 21 shrubs, and 163 herbaceous plants.

During 1962 we collected 102 of these species, exclusive of the Cyperaceae and Juncaceae, plus 98 species in addition to those listed by Harper (Table 1).

If Harper's values are used to estimate an absolute number of species, and these values are applied to our findings at the 75 per cent level, then we found at least a 33 per cent increase in the number of species since 1906.

Coincidently, the habitats with the greatest numbers of species were those where grazing was most intense. The vegetation in these areas was closely cropped as opposed to the bulky undecomposed litter found on the unpastured areas. Annual burning has been an important factor in removing litter and releasing nutrients. Thus, fire has provided optimum conditions for the most heliophytic species. Essentially then, fires and pastures have made new habitats with new ecological niches and the species list would expectedly be greater. The large number of immigrant species in the moist pine barrens may be related also to the introduction of pioneers through regular supplemental feeding of cattle during winter with hay from various origins. Furthermore, vehicular traffic from logging operations, bulldozers and highways has increased. Railroads pass most of the moist pine barrens and plants may be introduced via these routes.

The Gramineae with twenty-two new introductions had the greatest increase in number of new introductions, and the majority of these came from two heavily grazed areas. The Compositae with eighteen introductions were rather evenly distributed among the collection areas. Most of the remaining new introductions came from all seven areas.

Harper did not include *Sphagnum* spp., but several unidentified species of sphagnum moss were collected in 1962 from five of the seven areas. *Ranunculus laxicaulis, Polygonum hydropiperoides,* and *Euphorbia corollata* now fill certain gaps in systematics that occurred in Harper's report.

We failed to find fifty (Table 2) of the species reported by Harper. Probable reasons are: (1) the abundance rating Harper gave to almost half of these had a low index-value; that is, they were uncommon or inconspicuous, (2) our collections did not include the pine barrens in southwestern Georgia as did some of Harper's observations, and (3) our collections were from semi-agrarian land, whereas Harper probably observed more undisturbed habitats.

Modern botany places very little significance on flower color as a classification scheme, nevertheless, in habitats where aluminum ions are important enough to either fringe

the area of toxicity (Plummer 1963) or affect flower coloration as may be the case in these habitats, then Harper's observations may justifiably be paralleled. A predominance of white, purple and yellow flowers occurred early in this century, and these colors prevail today. On the basis of relative percentages of numbers of species, the abundance of white-flowered species decreased fourteen percent, the yellow-colored species increased eleven percent, and the percentage of purple-flowered plants remains unchanged. The number of red-flowered species increased from five to six. Of the 98 new introductions, about one-third had white or cream-colored flowers, another third had yellow flowers, about 20 percent had purple or blue flowers and the remainder of the species were mostly grasses, sedges or rushes.

Sarracenia species in the moist pine barrens associate with *Sporobolus teretifolius* Harper. Certain evidence (Roberts and Oosting, 1958; Plummer, 1963) suggests that *Aristida stricta* occurs on the very wet sites. *Aristida stricta* in vegetative condition may easily be confused with *Sporobolus teretifolius*, but *Aristida* occurred most abundantly in the driest parts of the areas used in this study. As the water table in the moist pine barrens is lowered by agricultural practices and by roadside drainage ditches, *Aristida* has moved to within 20 feet of *Sarracenia flava* in at least one area and it may be closer in other moist pine barrens. *Aristida stricta* is omitted in this report as a member of the flora of the moist pine barrens.

Summary

The flora of the moist pine barrens has changed within the last fifty to sixty years with the introduction of about 98 new occurrences and the elimination of perhaps fifty species. The floristic changes probably result from recent changes in land utilization. Coincident with intensified grazing the new introductions are assocated with: (1) regulated burning that has been commonly practiced, (2) the import of new species through winter supplements of hay for cattle, and (3) increased vehicular traffic in the vicinity of the habitats.

TABLE 1

New occurrences in the moist pine barrens[1]

[1]Genera listed according to Small (1933).

TREES	
Pinus palustris Mill.	Liriodendron tulipifera L.
P. taeda L.	Acer rubrum L.
SHRUBS AND VINES	
Smilax laurifolia L.	A. hypericoides L.
Rubus betulifolius Small	Rhododendron serrulatum (Small) Millais
Ilex myrtifolia Walt.	Vaccinium tenellum Ait.
Ceanothus microphylla Michx.	Viburnum cassinoides L.
Ascyrum pumilum Michx.	
FORBS	
Sagittaria graminea Michx.	S. foliosa Fern.
Lachnocaulon glabrum Koern.	Asclepias stenophylla Gray
Mayaca fluviatilis Aubl.	Phlox pilosa L.
Xyris ambigua Beyr.	Verbena bonarensis L.
X. torta J. E. Sm.	Scutellaria integrifolia L.
Hypoxis hirsuta (L.) Coville	Koellia flexuosa (Walt.) Mac M.
H. juncea J. E. Smith	Gratiola neglecta Torrey
H. sp.	G. ramosa Walt.
Gyrotheca tinctoria (Walt.) Salisb.	Ilysanthes monticola (Nutt.) Raf.
Spiranthes vernalis Engelm. & Gray	Linaria canadensis (L.) Dum.
Polygonum hydropiperoides Michx.	Gerardia fasciculata Ell.
Phytolacca americana L.	Buchnera floridana Gandoger
Ranunculus laxicaulis (T. & G.) Darby	Ruellia oblongifolia Michx.
Drosera brevifolia Pursh	Utricularia fibrosa Walt.
Cassia nictitans L.	U. virgatula Barnh.
Geranium carolinianum L.	Plantago virginica L.
Oxalis filipes Small	Houstonia caerulea L.
Euphorbia corollata L.	Diodia tetragona Walt.
Piriqueta caroliniana (Walt.) Urban	D. virginiana L.
Viola lanceolata L.	Lobelia nuttallii Roem. & Schult.
V. affinis Leconte	Vernonia noveboracensis (L.) Michx.
Centella erecta (L. f.) Fern.	Eupatorium capillifolium (Lam.) Small
Ptilimnium capillaceum (Michx.) Raf.	E. leucolepis T. & G.
Gelsemium rankinii Small	E. anomalum Nash.
Sabbatia paniculata (Michx.) Pursh	Trilisa odoratissima (Walt.) Cass.
	Solidago microcephala (Greene) Bush
	S. stricta Ait.

Pluchea foetida (L.) DC.
Erigeron strigosus Muhl.
Conyza canadensis (L.) Cron.
Gnaphalium peregrinum Fern.
Rudbeckia glabra DC.
R. serecea T. V. Moore
Helianthus tuberosus L.
Helenium tenuifolium Nutt.
H. brevifolium (Nutt.) A. Gray
H. vernale Walt.
Pyrrhopappus carolinianus (Walt.) DC.

GRASSES

Erianthus coarctatus Fern.
E. giganteus (Walt.) Muhl.
Andropogon perangustatus Nash
A. stolonifer (Nash) A. Hitchc.
Axonopus affinis Chase
Paspalum longipilum Nash
P. setaceum Michx.
P. urvillei Stevd.
Panicum albomarginatum Nash
P. longiligulatum Nash
P. scabriusculum Ell.
P. lancearium Trin.
P. leucothrix Nash
P. anceps Michx.
P. condensum Nash
P. consanguineum Kunth
P. ensifolium Baldw. ex. Ell.
P. scoparium Lam.
P. trifolium Nash
P. virgatum L.
Setaria geniculata (Lam.) Beauv.
Agrostis scabra Willd.

TABLE 2

Species occuring in 1906 but not observed in 1962[1]

[1]Species list according to Harper (1906).

TREES

Pinus serotina
Liquidambar styraciflua

SHRUBS AND VINES

Itea virginica
Cliftonia monophylla
Pieris phillyreifolia
Xolisma sp.
Styrax pulverulenta

FORBS

Sagittaria mohrii
Mayaca aubletii
Xyris fimbriata
X. neglecta
X. platylepis
Syngonanthus flavidulus
Eriocaulon lineare
Melanthium virginicum
Oxytris crocea
Aletris lutea
Drosera filiformis
Sarracenia rubra
Rhexia filiformis
R. stricta
Eryngium yuccifolium
Centella repanda
Sabbatia lanceolata
Physostegia denticulata
Koellia hyssopifolia
Sophronanthe pilosa
Gerardia paupercula
G. skinneriana
Utricularia macrorhyncha
U. subulata
Eupatorium verbenaefolium
Carphephorus pseudo-liatris

Aster eryngiifolius
Rudbeckia mohrii
R. nitida
Helianthus undulatus
Coreopsis angustifolia
Baldwina atropurpurea
B. uniflora
Leptopoda helenium
Carduus lecontei

GRASSES

Andropogon tracyi
Paspalum curtisianum
Panicum combsii
P. hemitomon
P. melicarium
Arundinaria tecta

FERNS

Anchistea virginica

CLUB-MOSSES

Lycopodium pinnatum

Literature Cited

Beesley, T. E. 1948. Soil Survey. Chandler County, Georgia. U. S. Bur. Plant Ind., Soils Agric. Engin. Soil Survey Series 1939, no. 6. 46 p.

Harper, R. W. 1906. A phytogeographical sketch of the Altamaha Grit Region of the Coastal Plain of Georgia. Ann. N. Y. Acad. **17**: 1-415.

Moon, J. W. 1928. Soil survey of Cook County, Georgia, U. S. Bur. Chem. Soils. Soil Survey Series 1928, no. 11. 28 p.

Phillips, S. W., E. W. Knobel, G. L. Fuller, J. W. Moon. 1928. Soil Survey, Dooly County, Georgia. U. S., Bur. Chem. Soils. Soil Survey Series 1923, no. 10. p. 217-305.

Plummer, G. L. 1963. Soils of the pitcher plant habitats in the Georgia Coastal Plain. Ecology **44**: 727-734.

Roberts, P. R. and H. J. Oosting. 1958. Responses of Venus fly trap *(Dionaea muscipula)* to factors involved in its endemism. Ecol. Monog. **28**: 193-218.

Small, J. K. 1933. Manual of Southeastern Flora, Publ. by author. N. Y. 1554 p.

Sweet, A. T. and B. W. Tillman. 1918. Soil Survey of Brooks County, Georgia. U. S. Bur. Soils. Soil Survey Advance Sheets, 1916. 42 p.

TAXONOMY OF THE NARROW-LEAVED VERNONIA OF THE SOUTHEASTERN UNITED STATES[1]

SAMUEL B. JONES, JR.

The narrow-leaved *Vernonia* (i.e., the Angustifoliae and Scaberrimae species groups of Small, 1933) occur on sandy areas from North Carolina into Florida and Mississippi. They were chosen for systematic study because of the conspicuous variability within and among some of the taxa in this group. The usual field and herbarium studies were supplemented by biosystematic investigations.

In the course of this investigation, friendly assistance has been received from many persons. It is not possible to thank them all specifically, but my sincere thanks are none the less real. I am most particularly indebted to Dr. W. H. Duncan (University of Georgia), under whose direction this paper as part of a dissertation was undertaken, for his advice, criticism, and encouragement. The author wishes to thank the curators of the herbaria that kindly lent the specimens of *Vernonia* used in this study. Loans were obtained from the following herbaria: DUKE, Duke University; FLAS, University of Florida; FSU, Florida State University; GA, University of Georgia; GH, Gray Herbarium; MO, Missouri Botanical Garden; NCSC, North Carolina State College; NY, New York Botanical Garden; PH, Academy of Natural Sciences; US, United States National Museum; USF, University of South Florida. Abbreviations are from Lanjouw and Stafleu (1959).

HISTORICAL ACCOUNT

The first description of a narrow-leaved *Vernonia* was by Walter (1788) in "Flora Caroliniana." He applied the name *Chrysocoma graminifolia* Walt. with the description "herbacea, foliis lineari-lanceolatis glabris, floribus corymbofis."

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[1]A portion of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate School of the University of Georgia.

Michaux (1803) described the same taxon and gave it the name *Vernonia angustifolia* Michx. The second taxon in the group was named and described by Nuttall (1818) as *V. scaberrima* Nutt., noting "Calix (sic) scales filiformly terminated as in *V. noveboracensis.*" Rafinesque (1838) apparently applied the name *V. brevifolia* Raf. to the taxon *V. scaberrima* Nutt.

An erroneous identification of a specimen of *V. angustifolia* Michx. as *V. fasciculata* Michx. by De Candolle (1836) has caused his description of *V. fasciculata* Michx. to be based on a specimen of *V. angustifolia* Michx. (Torrey and Gray, 1841). *V. angustifolia* Michx. and *V. scaberrima* Nutt. were combined by Torrey and Gray (1841) into one species (*V. angustifolia* Michx.).

A third taxon of the narrow-leaved southeastern *Vernonia* was described and named by Chapman (1878) as *V. angustifolia* Michx. var. *pumila* Chapm., from south Florida. Gray (1884) followed the earlier treatment of Torrey and Gray (1841) ; however, he gave varietal status to var. *scaberrima* (Nutt.) A. Gray and listed var. *pumila* Chapm. and var. *texana* A. Gray. This varietal treatment of *V. texana* (A. Gray) Small has caused the appearance of the name *V. angustifolia* Michx. in floras from west of the Mississippi River. This occurred in "Plants of Arkansas" by Branner and Coville (1888) who also changed the name of *V. angustifolia* Michx. to *V. "granienifolia"* (sic) Coville.

Kuntze (1891) changed the generic name *Vernonia* to *Cacalia* and applied the name *C. graminifolia* (Walt.) Kuntze to *V. angustifolia* Michx. A fourth taxon was described from the sand hills bordering the Altamaha River in Liberty County, Georgia, by Small (1898) and named *V. pulchella* Small. Mohr (1901) used the name *V. graminifolia* (Walt.) Mohr for *V. angustifolia* Michx. Although the oldest specific name is Walter's (1788) *graminifolia*, the use of the binomial *V. graminifolia* (Walt.) Mohr in antedated by *V. graminifolia* Gardner, applied in 1847 to a Brazilian species (Gleason, 1906). Small (1903) changed the name and rank of *V. angustifolia* Michx. var. *pumila* Chapm. to *V. blodgettii* Small. Gleason (1906) noted that the use of Chapman's

varietal name for the species is prevented by the publication of the name *V. pumila* Kotschy and Peyr. for an African species.

In 1906, Gleason published "A revision of the North American Vernonieae," listing seven narrow-leaved southeastern species. Included were three new narrow-leaved southeastern *Vernonia* (*V. recurva* Gleason, *V. dissimilis* Gleason, and *V. concinna* Gleason). He separated this group under study into two species groups, Pulchellae and Angustifoliae, based on bract tip shape. In 1922, Gleason used this same treatment in "North American Flora." Small (1933) followed Gleason's (1906) treatment of this group except that he used the name Scaberrimae instead of Pulchellae for one of the species groups. Apparently the last taxonomic shifting was by Schubert (1936) when she placed *V. pulchella* Small as a variety of *V. scaberrima* Nutt.

TAXONOMIC TREATMENT

Benson (1962) stated that any step toward classification of a plant group is an important contribution to knowledge. He also pointed out that the goal of taxonomy is synthesis of data from various fields. Data from several disciplines are used in the following section to clarify fundamental taxonomic problems and to serve as bases for improved classification of the group.

Evolutionary Relationships

The presence of relatively few minor morphological differences is evidence of close relationships among taxa of the group. The taxa considered here apparently diverged from a common ancestor during past geological history, and, except for the allopatric taxon *V. blodgettii* of south Florida, followed this with incomplete merging by the pattern of sympatric introgression. Present evidence does not warrant separation of these taxa into two species groups as did Gleason (1906) and Small (1933).

There is a gap of 80 miles between *Vernonia blodgettii* and those sympatric taxa to the north. This geographic iso-

lation is apparently an effective barrier to gene exchange as its populations show only the minor variation expected in out-crossing population systems. This taxon easily crosses in experimental situations with the other taxa of the study, producing fertile F_1 hybrids. Transplant studies indicated that *V. blodgettii* has a different range of ecological tolerances than the other taxa, thus, perhaps, accounting for its geographic isolation. Morphologically, *V. blodgettii*, is quite distinct. Evaluation of present evidence indicates that this taxon should remain at species rank.

The only confirmed occurrence of *Vernonia pulchella* is in a very limited area of what is known as the Low Terraces in southeast Georgia. It has maintained its identity in this restricted range except for a narrow band at the border of its range where introgression has occurred with *V. scaberrima*. It should be noted that *V. pulchella* differs from *V. scaberrima* in several features such as pubescence, leaf shape, leaf size, leaf texture, size of epidermal cells, compactness of leaf blade mesophyll, and, quite significantly, ecological habitat. Experimental evidence shows that *V. pulchella* is inter-fertile with the other taxa of this study. The resulting F_1 hybrids are vigorous and fertile in all cases. The crosses between *V. pulchella* and *V. scaberrima* resulted in offspring intermediate between the two parents. Ease of experimental hybridizations indicates that isolation is probably ecological. Morphologically, *V. pulchella* is quite distinct. It is concluded that *V. pulchella* should retain species rank.

Examination of the type of *V. recurva* indicated that it is a hybrid between *V. pulchella* and *V. scaberrima* as it only occurs where *V. pulchella* and *V. scaberrima* are sympatric. Artificial crosses of these two taxa produced fertile, vigorous, and intermediate plants closely resembling the type specimen. The backcrosses closely resembled the recurrent parent. Morphological studies of local population samples involving these two taxa substantiated the hypothesis of the hybrid origin of *V. recurva*. The status of *V. recurva* should be altered from species to hybrid. The hybrids may be able to survive due to the presence of a spectrum of

ecological niches between the habitats of the two parents.

The taxa of this study are usually isolated ecologically from the wide-leaved *Vernonia* which occur only in mesic habitats. This isolation is not always effective, and hybridization occurs between narrow-leaved and wide-leaved *Vernonia*. For example, hybridization between *V. angustifolia* and the wide-leaved *V. ovalifolia* in middle Florida has resulted in hybrids previously known as *V. concinna*. Fertile, vigorous, and intermediate artificial hybrids were easily produced in the greenhouse and they were very similar to the type of *V. concinna*. Backcrosses approached the recurrent parent in morphology. Some introgression was indicated from studies of local population samples. The status of *V. concinna* should be altered from species to hybrid.

Introgression of *V. angustifolia* with wide-leaved *V. altissima* in east Alabama and west Georgia has apparently resulted in a form which has been named *V. dissimilis*. In this instance the artificial hybrid was not made; however, crosses of *V. angustifolia* with *V. dissimilis* yielded hybrids closely resembling *V. angustifolia* in most characteristics, as would be expected in a backcross. Also, this hypothesis is supported by the results of detailed analysis of a number of local population samples which indicated introgression. *V. dissimilis*, therefore, should be reported as a hybrid.

Similarly, hybridization was also detected between narrow-leaved *Vernonia* and *V. missurica*, *V. acaulis*, and *V. noveboracensis*, which are wide-leaved species. The presence of these hybrids should be noted; however, it would serve little purpose to name these hybrids and confound the literature, especially since individuals of hybrid origin will continue to be found by field botanists where isolation barriers are broken or incomplete.

The population systems that make up the complex of *V. angustifolia* and *V. scaberrima* are the most extensive and appear to be the most complex of the narrow-leaved *Vernonia*. Present evidence indicates that this complex consists of one variable species consisting of three infraspecific taxa at varietal rank with some local variation. The three varieties are *V. angustifolia* var. *angustifolia* of the Carolinas

and Georgia, var. *scaberrima* of southeast Georgia and southwest South Carolina, and var. *mohrii* of south Alabama, southeast Mississippi, north Florida, and southwest Georgia. The presence of long filiform bract tips and 20-30 flowers per head characterize var. *scaberrima*, while var. *mohrii* is characterized by the presence of bracts with acute to slightly acuminate tips and 8-15 flowers per head and var. *angustifolia* is somewhat intermediate between the two, having acuminate bract tips and 16-20 flowers per head. Although these three varieties are morphologically distinct within their respective centers of distribution, the present data indicate that the taxa are connected by bands of intermediates. In the zones of intergradation characters normally found in the three varieties occur in such combinations that it is frequently difficult to assign a varietal epithet to certain plants.

Artificial crosses between these three varieties produced fertile hybrids, indicating that this could occur in the field. The hybrids are similar to many specimens from the transition zones. Based on observations of herbarium specimens and living material, it appears that backcrossing and subsequent introgression of characters occur at approximately the same rates in both directions. Factors most responsible for keeping these taxa apart are probably ecological in nature.

Three hypotheses should be considered in an attempt to explain the pattern of variation in *V. angustifolia*. The first is mutation, recombination, and natural selection within the taxa. The second is extensive hybridization with repeated backcrossing where the ranges of the taxa overlap, and the third hypothesis is a combination of the first two.

Mutation, recombination, and natural selection could result in the formation of clines of morphological characteristics, as was detected in *V. angustifolia* by utilizing a characteristic-by-characteristic study of local population samples. Stebbins (1950) noted that clines, as contrasted with abrupt changes of morphological features, are probably very common among plant species. Assuming that the ancestors of *V. angustifolia* migrated into the south-

eastern United States via Mexico and Texas, as postulated by Gleason (1923), then clinal or ecotypic variation might be prevalent. This could be due to gene mutation, gene recombination, and natural selection concurrent with migration from one area to another. If natural selection, and not hybridization, is the primary cause of variation in *V. angustifolia,* then gene combinations are a reflection of the environmental conditions or adaptive responses. Mutant genes might drift through the populations and become fixed due to their selective value when the taxa migrated into new or slightly different environments. Stebbins (1950) stated that the direction of evolution is determined largely by the genes accumulated through previous mutations and already present in the population. Natural selection clearly plays an important role in perpetuating accumulated small genetic changes.

The second possible explanation of these morphological clines in *V. angustifolia* is that hybridization occurred in those localities where the varieties are sympatric. Also, it is not enough merely to account for these clines by hybridization alone without including introgression, i.e., gene flow between interfertile taxa through their hybrids by means of repeated backcrossing and selection. The centers of distribution of the three varieties of *V. angustifolia* are probably the Sand Hills of south Georgia, the Fall Line Hills of the Carolinas, and south Alabama, west Florida, and southeast Mississippi. Pleistocene disturbances could have separated the ranges of var. *scaberrima,* var. *angustifolia,* and var. *mohrii.* Later dispersion of these taxa could have allowed hybridization and backcrossing, producing plants intermediate in phenotypic characters where their ranges overlap. The suggestion of hybridization does not preclude that mutation, recombination, and natural selection would not also be present and operative.

It is very difficult to ascribe the variation pattern of *V. angustifolia* with certainty to one or the other of the two hypotheses. Natural selection, although admittedly very important in the evolution of any system of populations

cannot completely account for this type of variation. There is an intergradation of characters between var. *scaberrima* and var. *angustifolia* and also between var. *angustifolia* and var. *mohrii*. In certain portions of the range, namely southeast Georgia, the gradient changes abruptly in respect to some characters. Abrupt changes in gradients of morphological characteristics when not accompanied by correlated changes in the environment are evidence against natural selection and favor the theory of hybridization as the primary cause of the variation patterns in *V. angustifolia*. The problem is further complicated by the location of the center of the range of var. *angustifolia* (which has some characters intermediate between the other two varieties) in the Carolinas and not between the centers of the ranges of the other two varieties. Theoretically, extensive hybridization and backcrossing between taxa over a considerable length of time would produce a broad zone of intermediates between taxa centers. Although the varieties are somewhat variable within their respective centers of distribution, the greatest amount of variation occurs where the ranges overlap. The latter situation, along with the inherent variation, makes a combination of the two hypotheses seem likely, with perhaps more evidence favoring the hybridization hypothesis.

Based on the evidence and conclusions as stated above,

TABLE 1. A comparison of Small's (1933) and the present author's taxonomic concepts of the narrow-leaved *Vernonia*.

Small (1933)	Jones
Scaberrimae	Angustifoliae
V. pulchella	*V. blodgettii*
V. recurva	*V. pulchella*
V. scaberrima	*V. angustifolia*
Angustifoliae	var. *angustifolia*
V. angustifolia	var. *scaberrima*
V. dissimilis	var. *mohrii*
V. concinna	Hybrids
V. blodgettii	*V.* × *recurva*
	V. × *concinna*
	V. × *dissimilis*

the taxonomic status of the narrow-leaved *Vernonia* of the southeastern United States is summarized in Table 1. Also, Table 1 compares the treatment of Small (1933) with that of the present author.

Gleason (1923), in his paper "Evolution and geographic distribution of the genus *Vernonia* in North America", stated that there can be little doubt that the ancestral home of the North American *Vernonia* is tropical South America. Gleason based his conclusions on the existence of diverse and primitive South American species. He also suggested that migration and evolution occurred northward and eastward from Central America, through Mexico and Texas. Evolution following the eastward migration then produced the narrow-leaved taxa of the southeastern United States of this study, which retain the primitive involucre, narrow leaves, and low stature of the Texanae from Texas and Mexico. Wodehouse (1928) confirmed Gleason's hypothesis using pollen morphology.

Recent immigration and incomplete evolution of the taxa were stressed by Gleason. Stebbins (1950), however, noted that speciation usually occurs only on the presence of external or internal isolating mechanisms and that most speciation probably takes place in small populations which are more or less isolated unless there is strong selective pressure. Present evidence indicates that immigration may have been ancient, with isolation and divergence from a common ancestor followed by partial sympatric introgression. This could have led to Gleason's (1923) conclusion, namely, that ". . . they are not easily divided into species groups."

Plants ancestral to the present narrow-leaved *Vernonia* may have reached a variety of sandy ecological niches available in the land mass which is now the southeastern United States. Once established, this ancestor was probably isolated by successive periods of marine invasion of the Pleistocene. Under conditions of isolation, rapid evolution could occur. This is contrary to Gleason's (1923) stress on incomplete evolution rather than isolation pre-

ceding taxa differentiation. The present center of the greatest variation of these taxa in southeast Georgia may be due to the presence of several Pleistocene terraces which permit a variety of ecological niches. Also, the edaphic habitats available for these taxa are not uniform ecologically nor are they continuous in the area. This may explain the incomplete merging of the taxa as indicated by my population studies.

The evolutionary behavior of the allopatric species *V. blodgettii* of south Florida may be attributed to the presence of possible Pleistocene refugia in what is now Florida. These refugia have been discussed by James (1961) in "Endemism in Florida." These refugia might have functioned in providing isolating mechanisms, allowing *V. blodgettii* to evolve from its relatives in response to edaphic or other environmental factors of these Pleistocene refugia habitats of Florida. This may have been followed by migration of the habitat as the sea level receded accompanied by migration of *V. blodgettii* to its present range in south Florida.

Some of the variation necessary for evolution and which according to Stebbins (1950) is to be expected in cross-pollinated populations is evidently present within the populations of *Vernonia.* A possible source of new genes, other than mutation, is introgression with species of wide-leaved *Vernonia,* following partial breakdown of ecological barriers. Since it occurs today, it could have occurred in the past. The long bract tips of several of the taxa, resembling those of *V. noveboracensis* (a wide-leaved *Vernonia),* might have resulted from the inclusion of genes from outside the group. Hybridization experiments carried out to the F_2 and F_3 generations, as suggested by Anderson (1949), might prove fruitful in this area.

Speculation concerning the evolution of a group of taxa should also include possible influences of past changes in the earth's surface and climate. Paleogeologic and paleoclimatic data presented by Schuchert (1935) and Dunbar (1960) indicated that land was available since the Creta-

ceous Period for colonization by *Vernonia* in what is now the southeastern United States. The ancestor of the present taxa, if existent, could have moved into the newly opened habitats during or toward the close of the Cretaceous. Certain *Vernonia* of this group are very abundant on the Cretaceous Fall Line Hills from west Alabama into North Carolina. Isolation of the ancestral populations from those of their own kind to the west could have occurred in the Eocene Epoch by means of the Mississippi Embayment. These early populations (Texanae species group) of the Eocene, if existent, were probably sympatric and morphologically similar.

With the uplift of the Schooley Peneplane and subsequent climatic changes of the Miocene Epoch, along with Oligocene aridity, evolution may have induced a tendency toward Coastal Plain restriction. Isolation of the ancestral populations into small groups probably occurred during the Pleistocene Epoch, due to the formation of geographically separated refugia caused by sea level fluctuations. After the Pleistocene, wide areas were probably opened for colonization and finally migration caused the divergent

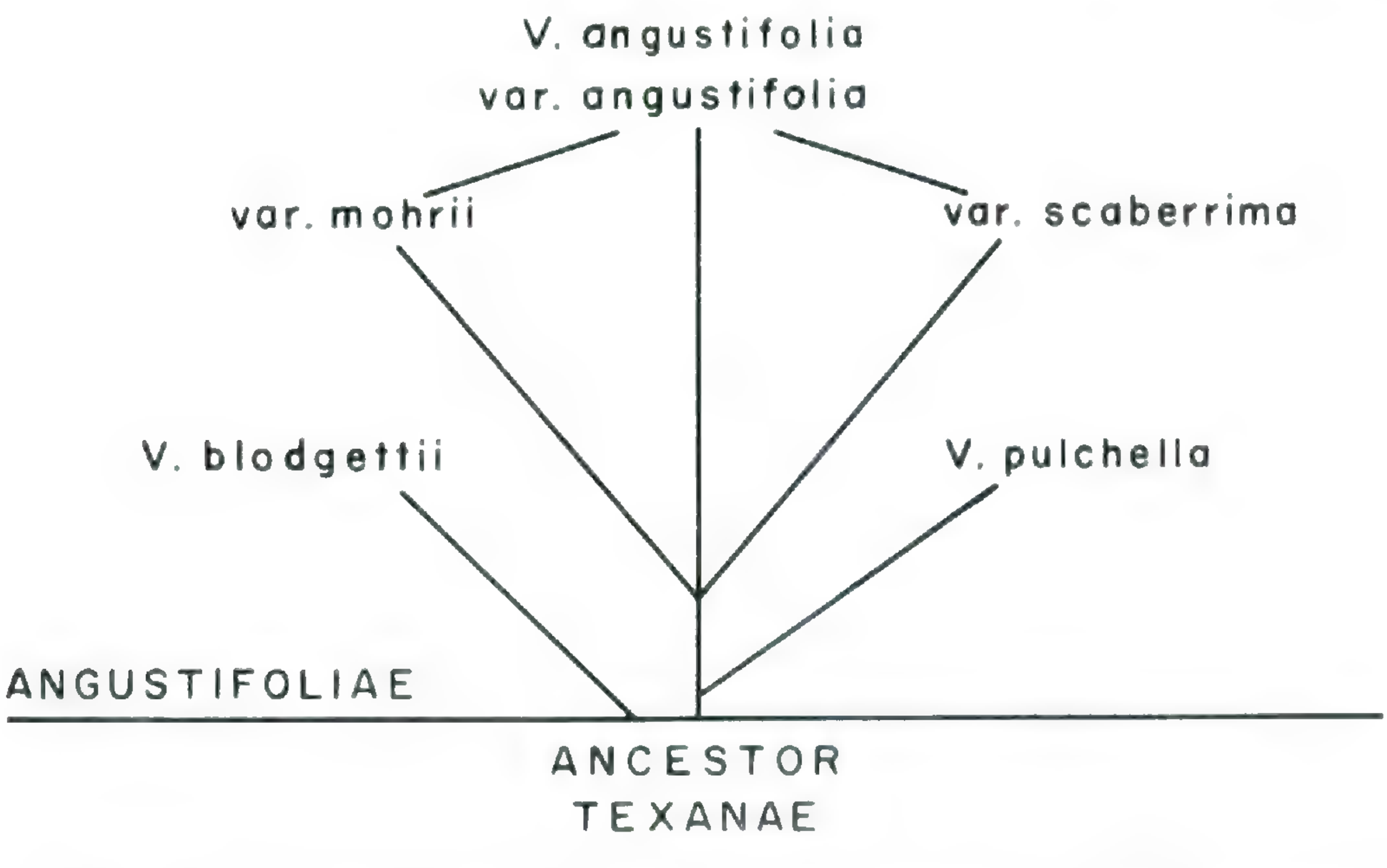

FIGURE 1. Diagrammatic scheme of the supposed phyletic sequence within the narrow-leaved *Vernonia* of the southeastern United States.

taxa to approach a partly sympatric condition, except for *V. blodgettii*. A diagrammatic scheme of the supposed phyletic sequence of the narrow-leaved *Vernonia* is presented in Figure 1.

Systematic Treatment

Small (1933) and Gleason (1906) separated these narrow-leaved *Vernonia* into two species groups; however, due to the many interrelationships of these taxa, I feel that they should be included in one species group (Angustifoliae). The Angustifoliae *Vernonia* are separated from the other southeastern *Vernonia* by their low stature and their characteristically crowded, narrow, linear to oblong-lanceolate or elliptic-lanceolate leaves. They are herbaceous perennials of the Coastal Plain of the southeastern United States.

A list of specimens is not included in this paper but will be prepared in mimeograph form and will be available. The hybrids that have been named are included in this treatment even though I do not believe in naming hybrids. They have been included in order to explain past treatments better.

Key to Species and Named Hybrids

1. Leaves mostly basal, leaf blades smooth and glabrous or nearly so, involucre loosely and irregularly imbricated, pappus light yellow, from the southern one-third of Florida ..... 1. *V. blodgettii*
1. Leaves scattered along stem, leaf blades scabrous to pubescent, involucre closely and regularly imbricated, pappus tawny to purple, not from southern Florida ..... 2.
   2. Cauline leaves narrowly linear or nearly so .... 2. *V. angustifolia*
   2. Cauline leaves elliptic, lanceolate to oblong or oblanceolate .... 3.
      3. Leaves, especially the lower, auriculate at the base, crisped, veins with conspicuous long brownish pubescence beneath .... 3. *V. pulchella*
      3. Leaves not as above ..... 4.
         4. Bract tips over 1.5 mm long ..... 4. *V.* × *recurva*
         4. Bract tips 0.1-0.5 mm long ..... 5.
            5. Leaves lanceolate, scabrous, especially at the margins above, sparsely pubescent below, from east Alabama and west Georgia ..... 5. *V.* × *dissimilis*
      5. Leaves oblanceolate, scabrous to almost glabrous above, almost glabrous below, from northern one-half of Florida ..... 6. *V.* × *concinna*

1. Vernonia blodgettii Small, Flora S.E. U.S. 1160. 1903.
Type: Blodgett, (NY). Woods, Pine Key, Monroe County, Florida.
Vernonia angustifolia Michx. var. *pumila* Chapm. Bot. Gaz. 3: 5. 1878.

Stems erect, glabrous, often branched at base, 2-5 dm tall. Leaves mostly basal, 1.8-6.9 cm long, 0.1-1.0 cm wide, linear or nearly so, glabrous above, lightly glandular dotted below, tips obtuse to acute, attenuate at the base, margins slightly revolute, entire. Inflorescence loose, irregular, with few heads. Heads about 21-flowered. Involucre loosely and irregularly imbricated, campanulate, 5.0-8.5 mm high, 5.5-10.5 mm wide. Bracts deltoid to lanceolate, inner 3.9-6.7 mm long, outer 1.7-3.5 mm long, purple, glabrous to slightly pubescent. Bract tips acute to subacute, 0.1-0.5 mm long. Achenes pubescent, ribbed, 2.3-2.7 mm long. Pappus light yellow, bristles 5.5-7.8 mm long, scales irregular, 0.5-0.8 mm long.

Distribution: Southern third of Florida from Indian River, Highlands, and Charlotte Counties south to and including the Florida Keys (see Figure 2).

2. Vernonia angustifolia Michx.

Stems erect, pubescent below, sparsely pubescent above, simple to the inflorescence, 4-11 dm high. Leaves crowded, 4-11 cm long, 0.1-0.6 cm wide, linear, scabrous above, scabrous or sparsely pubescent below, tips acute, bases attenuate, margins revolute, entire or with callus teeth. Inflorescence compact to loose and open. Heads 8-30-flowered. Involucre campanulate, 4-10 mm high, 4-10 mm wide. Bracts: inner lance-ovate to lanceolate, outer triangular-subulate to lanceolate, inner 2-8 mm long, outer 1.4-7.0 mm long, purple to greenish, glabrous or puberulent on back, ciliate or entire. Bract tips acute to long acuminate, inner 0.1-4.8 mm long, outer 0.1-5.3 mm long. Achenes pubescent on the ribs, 2.5-3.2 mm long. Pappus tawny to purplish, bristles 5.5-7.0 mm long, scales narrow, 0.4-0.8 mm long.

Distribution: The Coastal Plain of North Carolina, South Carolina, Georgia, and Alabama, the northern half of Florida, and southeast Mississippi.

The tremendous variability of this species has caused much difficulty in plant identification. Lack of an adequate series of specimens and data of an experimental nature has precluded in the past an adequate understanding of this taxon. My results, based on both experimental and morphological evidence, supports the hypothesis that the variability is the result of introgression with related taxa and also the result of natural selection. *V. angustifolia* is

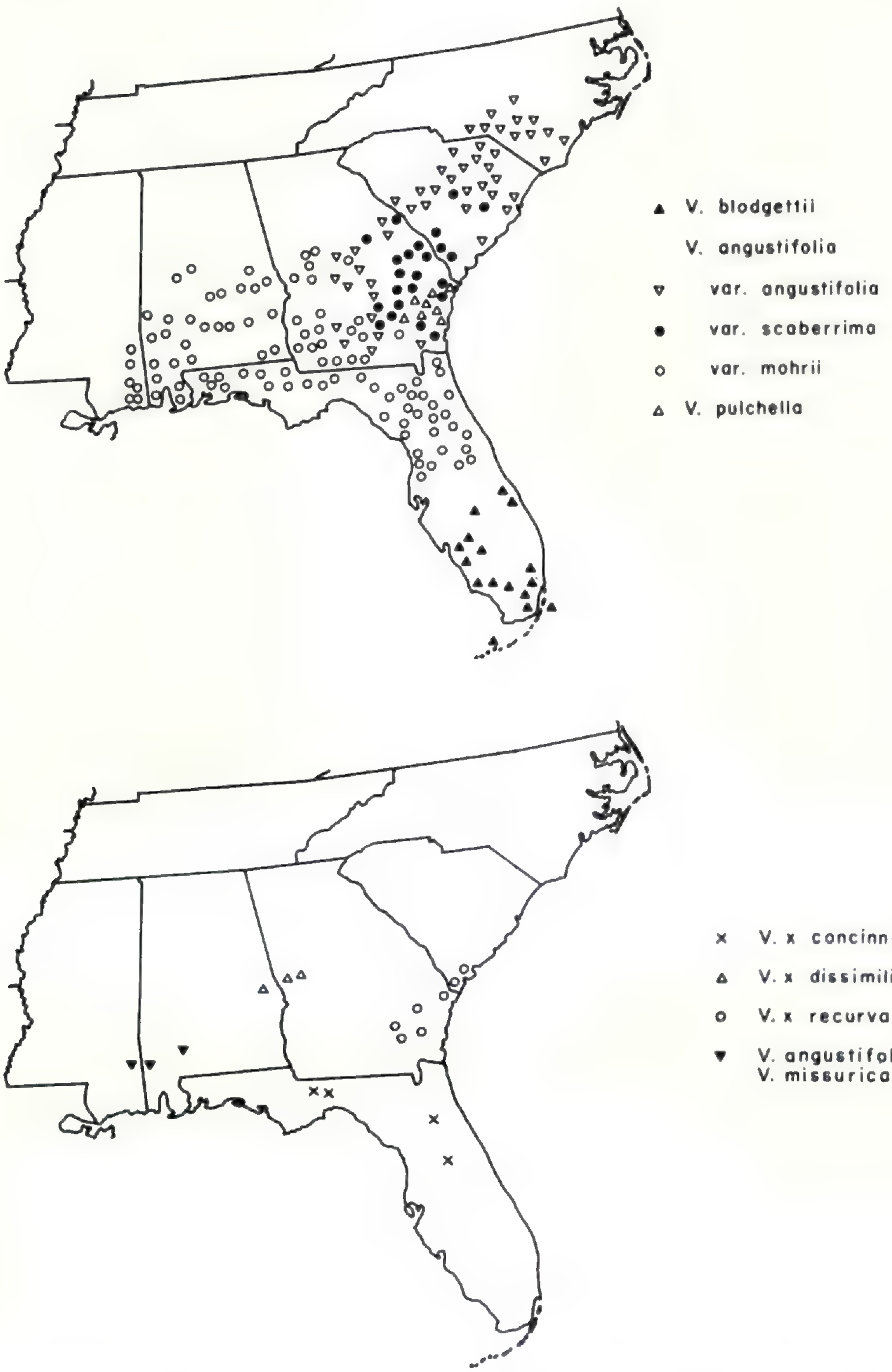

FIGURE 2. Distribution maps of the Angustifoliae species group of *Vernonia*. One dot is plotted every 25 to 30 miles for each taxon. *V. angustifolia* and *V. missurica* frequently hybridize in the area noted on the map.

a variable species consisting of three geographic varieties, with local variation.

Benson (1962) advocates the use of a table rather than keys to segregate varieties of a species. By use of a table, the burden of identification is thrown on a complex of characters rather than on one or two as in a key and it also furnishes a convenient means of character comparison from one variety to the next. The varieties and their contrasting characters are listed in Table 2.

TABLE 2
Characteristics of Varieties of *Vernonia angustifolia*

2a. var. *angustifolia*	2b. var. *scaberrima*	2c. var *mohrii*
Heads 16-19-flowered.	Heads 20-30-flowered.	Heads 8-15-flowered.
Bract tips acuminate to long acuminate, outer 0.3-2.5 mm long, inner 0.1-1.0 mm long.	Bract tips long acuminate, outer 1.5-5.3 mm long, inner 1.4-4.8 mm long.	Bract tips acute to acuminate, outer 0.1-1.2 mm long, inner 0.1-1.0 mm long.
Bracts outer 1.8-4.8 mm long, inner 3.5-7.7 mm long.	Bracts outer 3.9-7.2 mm long, inner 5.0-8.5 mm long.	Bracts outer 1.4-3.9 mm long, inner 2.5-6.5 mm long.
Involucre height 5.0-7.0 mm.	Involucre height 6.5-10.0 mm.	Involucre height 4.0-6.0 mm.
Involucre width 5.0-7.5 mm.	Involucre width 6.0-10.0 mm.	Involucre width 4.0-6.9 mm.

2a. Vernonia angustifolia Michx. var. **angustifolia.**

Type: Not examined (P), Photographs of type (GH, GA).
Vernonia angustifolia Michx., Fl. Bor.-Am. 2: 94. 1803.
Chrysocoma graminifolia Walt., Fl. Car. 196. 1788.
Vernonia fasciculata D.C., Prodromus 5: 63. 1836, not *Vernonia fasciculata* Michx.
Liatris umbellata Bertol., Nov. Comm. Bonon. 8: 79. 1846.
Vernonia granienifolia (sic) Coville, Rep. Geol. Surv., Ark. 4: 189. 1888.
Cacalia graminifolia (Walt.) Kuntze, Rev. Gen. 968. 1891.
Vernonia graminifolia (Walt.) Mohr, Contr. U.S. Nat. Herb. 6: 759. 1901.

Distribution: Southward from Harnett County, North Carolina, along the Fall Line Sand Hills and Coastal Plain into the eastern one-half of the Coastal Plain of Georgia.

This variety is intermediate in certain of its characteristics between var. *scaberrima* and var. *mohrii*. It is characterized by the presence of 16-20 flowers per head, with inner bracts 3.5-7.7 mm long, by inner bract tips 0.1-1.0 mm long, and with involucres from 5.0-7.0 mm high. This taxon is variable and shows evidence of introgression where its range overlaps with related varieties (see Figure 2).

2b. Vernonia angustifolia Michx. var. **scaberrima** (Nutt.) A. Gray, Syn. Fl. N. Am. 1: 91. 1884.
Lectotype: Baldwin (MO).
Vernonia scaberrima Nutt., Gen. 2: 134. 1818.
Vernonia brevifolia Raf., New Fl. 4: 77. 1838.
Vernonia angustifolia Michx. β T. & G., Fl. N. Am. 2: 59. 1841.

The lectotype of var. *scaberrima* was selected from several of the original specimens of this taxon which were studied and annotated by Nuttall. The Baldwin specimen (MO) seemed to best fit Nuttall's description of var. *scaberrima*.

This variety is characterized by the presence of long filiform bract tips, the inner bracts having tips at least 1.5 mm long. The heads are usually 20-30-flowered, the involucre ranges from 6.5-10.0 mm high, and the involucres are from 6.0-10.0 mm wide. Var. *scaberrima* intergrades with var. *angustifolia* and also with *V. pulchella* where it is sympatric with these taxa. Introgressant individuals are difficult to assign to a species or variety as the case may be.

Distribution: Southeast Georgia and to a limited extent in the Coastal Plain of the Carolinas (see Figure 2).

2c. Vernonia angustifolia Michx. var. **mohrii** var. nov.
Type: S. B. Jones 1406 (GA). 12.3 miles north of Citronelle, Washington County, Alabama.

Caulis simplex, erectus, parce pilosus, 4-12 dm altus. Folia crebra, linearia, supra scabra, subtus scabro-pilosa, 4-12 cm longa, 0.1-0.6 cm lata. Corymbus subumbellatus. Capitula cum 8-15 floribus. Involucrum 4.1-7.5 mm altum, 4.0-7.0 mm latum, bractae interiores 2.0-6.3 mm longae, bracteae exteriores 1.4-3.0 mm longae, apex acutus-mucronatus.

Stems simple, erect, sparsely pubescent, 4-12 dm high. Leaves

numerous, crowded, linear, scabrous above, scabrous-pubescent below, 4-12 cm long, 0.1-0.6 cm wide, revolute, frequently with callus teeth. Inflorescence subumbellate. Heads 8-15 flowered. Bracts: inner 2.0-6.3 mm long, outer 0.1-3.9 mm long, usually purple, glabrous or puberulent on the back, ciliate. Bract tips acute to acuminate, inner 0.1-1.3 mm long, outer 0.1-1.5 mm long. Achenes pubescent on the ribs, 2.8-3.2 mm long. Pappus purple-tawny, bristles 4-6 mm long, scales narrow 0.5-0.8 mm long.

This variety is characterized by the presence of bracts with acute to acuminate tips, involucres around 5.5 mm high, and heads with 8-15 (usually 13) flowers per head. Var. *mohrii* intergrades with var. *angustifolia* where these two taxa are sympatric. It also hybridizes with wide-leaved *Vernonia* such as *V. ovalifolia*, *V. altissima*, and *V. missurica* producing local variation and hybrid swarms.

Distribution: Coastal Plain of southwest Georgia, south Alabama, southeast Mississippi, and the northern half of Florida.

3. **Vernonia pulchella** Small, Bull. Torrey Bot. Club. 25: 145. 1898.
Type: J. K. Small, (NY). In and about the Altamaha River Swamp in Liberty County, Georgia.

Vernonia scaberrima Nutt. var. *pulchella* (Small) B.G. Schubert, Rhodora. 38: 369-372. 1936.

Stems erect, pubescent below, sparsely pubescent above, simple, 4-7 dm high. Leaves abundant, 2.7-6.0 cm long, 0.5-1.8 cm wide, auriculate at the base, upper leaves narrowed, elliptic-lanceolate to sub-pandurate, scabrous to pubescent above, pubescent below, conspicuous long brownish pubescence on veins beneath, tips of leaves acute, margins revolute and serrate, surface crisped. Inflorescence open, loosely branched. Heads 20-36-flowered. Involucre campanulate, 6.0-10.5 mm high, 5.0-9.1 mm wide. Bracts lanceolate to linear-elliptic, inner 5.0-10.0 mm long, outer 3.0-9.5 mm long, greenish purple, thinly puberulent on back, often ciliate. Bract tips long acuminate, inner 1.3-6.0 mm long, outer 1.1-6.0 mm long. Achenes with pubescent ribs, 2.7-3.1 mm long. Pappus tawny, bristles 5.5-9.0 mm long, scales narrow, 0.6-1.0 mm long.

Distribution: Restricted to a limited area of southeast Georgia on the Low Terraces which extend northeast and southwest of the Altamaha River (see Figure 2).

Introgression occurs between *V. pulchella* and *V. angustifolia* var. *scaberrima* where these two taxa are sympatric around the margins of the range of *V. pulchella*. *V. pul-*

chella has been able to remain distinct in a limited area, probably because of slight differences in the habitat that exclude var. *scaberrima*. A representative sample of the local populations was not available to Schubert (1936) when she changed the rank of *V. pulchella* from species to variety. *V. pulchella* differs in several features such as length and width of the leaves, pubescence of the stem and leaves, margins of the leaves, and size of the epidermal cells.

4. Vernonia × recurva Gleason (pro sp.)

(Vernonia pulchella × V. angustifolia var. *scaberrima)*

Vernonia recurva Gleason, Bull. N. Y. Bot. Gard. 4: 222. 1906. *Type: Harper 2009* (NY). Dry pine barrens near Hortense, Wayne County, Georgia. Isotype (MO).

Stems erect, pubescent, simple, 4-10 dm high. Leaves numerous, 2.5-8.4 cm long, 0.2-0.9 cm wide, lanceolate, scabrous above, scabrous to pubescent below, revolute, margins with scattered callus teeth. Inflorescence open. Heads 19-30-flowered. Involucre campanulate, 6-12 mm high, 5.5-9.0 mm wide. Bracts lanceolate, inner 5-10 mm long, outer 3.0-8.5 mm long, greenish-purple, almost glabrous on back, frequently ciliate. Bract tips long acuminate, inner 1.0-5.0 mm long, outer 1.2-5.7 mm long. Achenes pubescent on the ribs, 2.5-3.5 mm long. Pappus tawny, bristles 5.0-6.5 mm long, scales narrow, 0.6-1.0 mm long.

Distribution: Southeast Georgia and extreme southwest South Carolina on Low Coastal Terraces (see Figure 2).

Vernonia × recurva is found around the edge of the range of *V. pulchella* where *V. pulchella* is sympatric with *V. angustifolia* var. *scaberrima*. Individuals of hybrid origin may survive in nature due to differences in the habitat requirements of the two parents and a spectrum of ecological niches available between these two habitats. Anderson (1949) stated that there must be intermediate habitats for the hybrids to survive, as they tend to be intermediate in habitat requirements.

5. Vernonia × dissimilis Gleason (pro sp.)

(Vernonia altissima × V. angustifolia var. *mohrii)*

Vernonia dissimilis Gleason, Bull. N. Y. Bot. Gard. 4: 224. 1906. *Type: Earle and Baker 1189* (NY). Auburn, Lee County, Alabama. Stems erect, pubescent, simple to the inflorescence, 7-12 dm high.

Leaves 7-13 cm long, 0.5-1.2 cm wide, lanceolate, scabrous above especially near the margin, scabrous and sparsely pubescent below, margins revolute, serrate or with callus teeth. Inflorescence dense with many heads. Heads 10-19-flowered. Involucre campanulate, 3.8-7.3 mm high, 5.1-6.5 mm wide. Bracts ovate-lanceolate to deltoid, inner 3.1-5.5 mm long, outer 1.9-3.3 mm long, purple, glabrous to puberulent on the back, often ciliate. Bract tips acute to acuminate, inner 0.3-1.0 mm long, outer 0.5-1.4 mm long. Achenes pubescent on the ribs, 2.4-3.0 mm long. Pappus tawny to purple, bristles 5.1-6.5 mm long, scales narrow, 0.4-0.8 mm long.

Distribution: Fall Line Hills of east Alabama and the Pine Mountain area in West Georgia (see Figure 2).

6. Vernonia ×concinna Gleason (pro sp.)
(V. ovalifolia × V. angustifolia var. *mohrii)*
Vernonia concinna Gleason, Bull. N. Y. Bot. Gard. 4: 225. 1906.
Type: Nash 1759 (NY). Eustis, Lake County, Florida. Isotype (US).

Stems erect, mostly glabrous, simple to inflorescence, 5-10 dm high. Leaves 7-12 cm long, 0.3-1.3 cm wide, oblong linear to narrowly oblanceolate, scabrous to glabrous above, mostly glabrous below, narrowed to a sessile base, margins revolute, denticulate, entire or with callus teeth. Inflorescence loose. Heads 12-23-flowered. Involucre short-campanulate, 5.2-6.0 mm high, 4.5-6.7 mm wide. Bracts elliptic lanceolate, inner 3.2-4.6 mm long, outer 2.2-3.3 mm long, somewhat loosely imbricated, greenish-purple, glabrous or nearly so on the back, thinly ciliate. Bract tips acute to mucronate, inner 0.1-0.5 mm long, outer 0.1-0.7 mm long. Achenes pubescent on the ribs, 2.5-3.0 mm long. Pappus tawny, bristles 4.6-6.0 mm long, scales narrow, 0.3-0.6 mm long.

Distribution: Infrequent in the northern half of Florida, most common in the Lake Region (see Figure 2).

Literature Cited

Anderson, Edgar. 1949. Introgressive hybridization. John Wiley and Sons, Inc., New York. 109 p.

Benson, L. 1962. Plant taxonomy, methods and principles. Ronald Press, New York. 494 p.

Branner, J. C. and F. V. Coville. 1888. A list of the plants of Arkansas. Ark. Geol. Survey **4:** 189.

Candolle, A. A. de. 1836. Prodromus Systematis Naturalis **5:** 63. Paris.

CHAPMAN, A. W. 1878. An enumeration of some plants, chiefly from the semi-tropical regions of Florida, which are either new, or which have not hitherto been recorded as belonging to the flora of the Southern States. Bot. Gaz. **3:** 5.

DUNBAR, C. O. 1960. Historical geology. John Wiley and Sons, Inc., New York. 500 p.

GLEASON, H. A. 1906. A revision of the North American Vernonieae. Bull. N. Y. Bot. Gard. **4:** 144-243.

———. 1922. Vernonieae, North American Flora. N. Y. Bot. Gard. **33:** 52-95.

———. 1923. Evolution and geographic distribution of the genus *Vernonia* in North America. Am. J. Bot. **10:** 187-202.

GRAY, ASA. 1884. Synoptical flora of North America 1: 90-91. New York.

JAMES, C. W. 1961. Endemism in Florida. Brittonia, **13:** 225-244.

KUNTZE, OTTO. 1891. Revisio Generum Plantarum **2:** 968. Germany.

LANJOUW, J. and F. A. STAFLEU. 1959. The herbaria of the world. Regnum Vegatabile **15:** 1-249.

MICHAUX, A. 1803. Flora Boreali-Americana **2:** 94. Paris.

MOHR, C. 1901. Plant life of Alabama. Contrib. U.S. Nat. Herb. **6:** 759.

NUTTALL, T. 1818. The genera of North American plants **2:** 134.

RAFINESQUE, C. S. 1838. New flora and botany of North America 4: 77. Philadelphia.

SCHUBERT, B. G. 1936. Notes on *Vernonia.* Rhodora **38:** 369-372.

SCHUCHERT. C. 1936. Historical geology of the Antillean-Caribbean region. John Wiley and Sons, Inc., New York. 811 p.

SMALL, J. K. 1898. Studies in the botany of the southern United States. Bull. Torrey Bot. Club. **25:** 145.

———. 1903. Flora of the Southeastern United States, p. 1160, 1161. New York.

———. 1933. Manual of the Southeastern Flora. Univ. of North Carolina Press, Chapel Hill (reprint). 1554 p.

STEBBINS, G. L. 1950. Variation and evolution in plants. Columbia Univ. Press, New York. 643 p.

TORREY, J. and ASA GRAY. 1841. Flora of North America p. 59. Wiley and Putnam, New York.

WALTER, T. 1788. Flora Caroliniana, p. 196.

WODEHOUSE, R. P. 1928. The phylogenetic value of pollen-grain characters. Ann. Bot. **42:** 891-934.

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GENTIANA AUSTROMONTANA, A NEW SPECIES FROM THE SOUTHERN APPALACHIANS[1]

JAMES S. PRINGLE AND AARON J. SHARP

Gentiana austromontana Pringle & Sharp, sp. nov.

A *Gentiana clausa* calycibus caulibusque puberulis, apicibus corollarum clausarum subacutis, lobis corollarum angustioribus, et segmentibus appendicium corollarum triangulis differt.[2]

Type: *Pringle et al. 29372*, in grass just below "Gardens," Roan Mountain, Mitchell County, North Carolina (TENN; isotypes Herb. Royal Bot. Gard. Hamilton, ARIZ, DAO, GH, NCU, NY, US).

Higher elevations, especially in grassy balds, in the Blue Ridge Mountains, Virginia, West Virginia, North Carolina, and Tennessee.

Additional specimens examined:

NORTH CAROLINA: Allegheny: *Fox & Godfrey 2024* (KANU). Ashe: *Ashe 798* (NCU). Avery: *Steele 222* (GH, US); *Steele 259* (CAN); *Leonard & Leonard 16503* (US); *Blomquist 10483* (DUKE). Buncombe: *Standley & Bollman 10382* (US); *Sargent 7391* (SMU, WIS). McDowell: *Trapido 3688* (MIN, NY). Mitchell: *Merriam*, 9 Sept. 1892 (US); *Cannon 244* (NY); *Pringle 22007*, (Herb. Royal Bot. Gard. Hamilton, MTJB, SAP, WIS). Transylvania: *Alexander et al.*, 11 Oct. 1933 (NY). Watauga: *Ahles & Duke 49396* (NCU). Yancey: *Mark*, 8 Aug. 1956 (DUKE); *Ahles & Duke 50708* (NCU). TENNESSEE: *James*, 4 Oct. 1955 (TENN). Unicoi: *Woods & Woods 16529* (TENN).
VIRGINIA: Bedford: *Murrill* 24-27 Oct. 1916 (NY). Giles: *Iltis 302* (SMU). Roanoke: *Wood 5699* (GH). Washington: *Cronquist 4122* (NY). WEST VIRGINIA: Mercer: *Dickinson* 15 Sept. 1950 (WVA). Raleigh: *Utterback 236* (WVA).

Gentiana austromontana appears to be most closely related to *G. clausa* Raf., from which it differs most conspicuously in its less ventricose corollas, which taper to more

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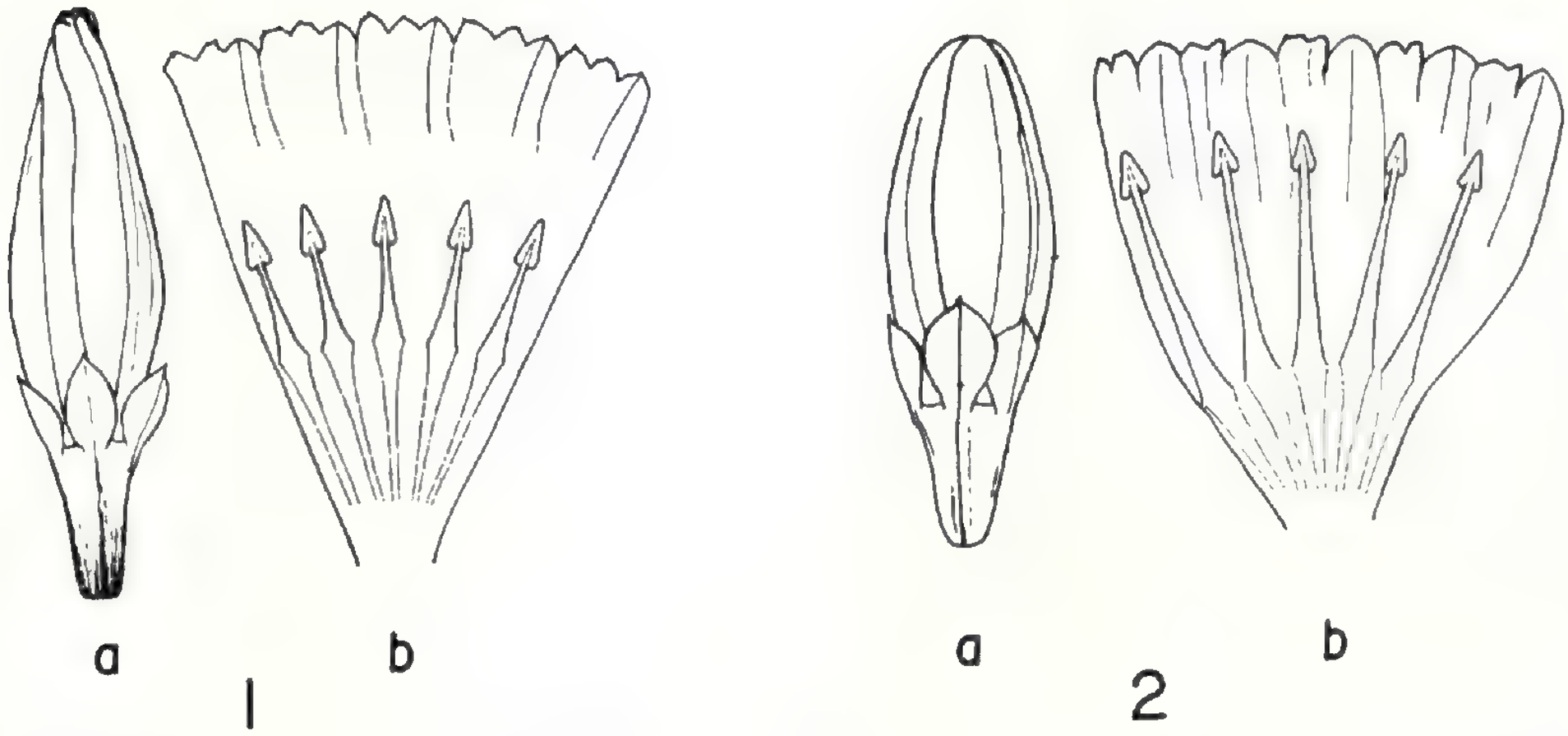
[1]Contribution from the Botanical Laboratory, University of Tennessee, New Series No. 243, and from the Royal Botanical Gardens, Hamilton, Canada, No. 1.

[2]We wish to express our appreciation to Dr. A. H. Moser of the Department of Classical Languages, University of Tennessee, for checking our Latin description.



FIGS. 1 and 2. Intact flowers (a) and corollas, slit longitudinally and flattened (b), × 1. Connate anthers have become separated in pressing. FIG. 1. *Gentiana austromontana* Pringle & Sharp. FIG. 2. *G. clausa* Raf.

acute summits. It differs also in its puberulent stems and calyx lobes; in its triangular corolla lobes, which are narrower and more acute; and in the shape of the free portions of the appendages of its corollas, which are divided into two nearly equal, triangular segments. The calyx lobes of *G. austromontana* are lance-ovate to elliptical, while those of *G. clausa* are obovate to nearly orbicular, and often larger. The filaments of *G. austromontana* become free from the corolla tube proportionately slightly higher than those of *G. clausa*, and their free portions are shorter, extending only about halfway from the level of their attachment to the summit of the corolla, while those of *G. clausa* extend two-thirds of this distance or more.

An affinity with *G. decora* Pollard is also indicated, but the corollas of the latter species are open or nearly so, with much larger lobes. Usually the flowers of *G. austromontana* are much more deeply colored than those of *G. decora*.

G. austromontana resembles *G. andrewsii* Griseb. in having closed corollas with the appendages visible at the summit, and has sometimes been mistaken for it. It differs from *G. andrewsii* in its puberulence, in its proportionately larger corolla lobes, and in the lower, triangular segments of the free portions of its corolla appendages.

G. austromontana may have evolved from a common ancestor along with *G. clausa*, *G. decora*, and other related species, or it may have arisen following the hybridization of *G. clausa* and *G. decora*, which are sympatric only in the limited area where this species is found. It appears to be a relatively stable component of the southeastern flora, occurring in some remarkably uniform populations.

ROYAL BOTANICAL GARDENS, HAMILTON, CANADA
DEPARTMENT OF BOTANY, UNIVERSITY OF TENNESSEE, KNOXVILLE, TENNESSEE

SOLIDAGO RUPESTRIS AND S. CANADENSIS— *Solidago rupestris* of Rafinesque (1820) has, at best, been considered as a "weak" species, closely related to *S. canadensis*, by many students of the genus. Others have reduced it to the status of a variety of *S. canadensis* or simply rejected it . There is no doubt that this usually glabrous plant looks much like *S. canadensis*. Moreover, the two have the same chromosome number, i.e., a somatic number of 18 (Beaudry, 1963). Nevertheless, *S. rupestris* can be separated easily from *S. canadensis* by means of its basal and lower cauline leaves, which are broadest above the middle in the first but broadest at the middle in the second (these leaves are absent in most specimens at the time of flowering), and also by means of the involucre size and the phyllary shape. These characters have not been mentioned in Rafinesque's original description, who, strangely enough, related his species not to *S. canadensis* but to "*S. odora.*" The shape of the lower leaves has been taken into account by Small (1903) but not considered by all later authors, and the characters of the head have never been pointed out, as far as I know.

The head of *Solidago rupestris* is larger than that of *S. canadensis* var. *canadensis*. Measurements made on the length of the involucres of 9 specimens of the first, range from 2.8 to 4.3 mm., with a general average of 3.6 mm., while those obtained on 8 specimens of the second range

Fig. 1. *Solidago canadensis* var. *canadensis* (upper row) and *S. rupestris* (lower row): entire head, followed by internal, median, and external phyllaries, × ca. 5. Fig. 1 to plate 13 J.

from 2.5 to 3.1 mm., with a general average of 2.9 mm. The shape of the phyllaries, however, is a better diagnostic character than the size of the head: the phyllaries of *S. rupestris* are oblong, blunt or even obtuse, while those of *S. canadensis* are linear and attenuate (Fig. 1).

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REFERENCES CITED

Beaudry, J. R. 1963. Studies on *Solidago* L. VI. Additional chromosome numbers of taxa of the genus *Solidago*. Can. Jour. Gen. Cyt. 5: 150-174.

Rafinesque, C. S. 1820. Annals of Nature 1:14.

Small, J. K. 1903. Flora of southeastern United States. New York.

LINUM MODESTUM, A NEW SPECIES FROM MEXICO[1]

C. Marvin Rogers

Plants of a well marked new species of flax appeared among a number of specimens recently borrowed from the United States National Museum.

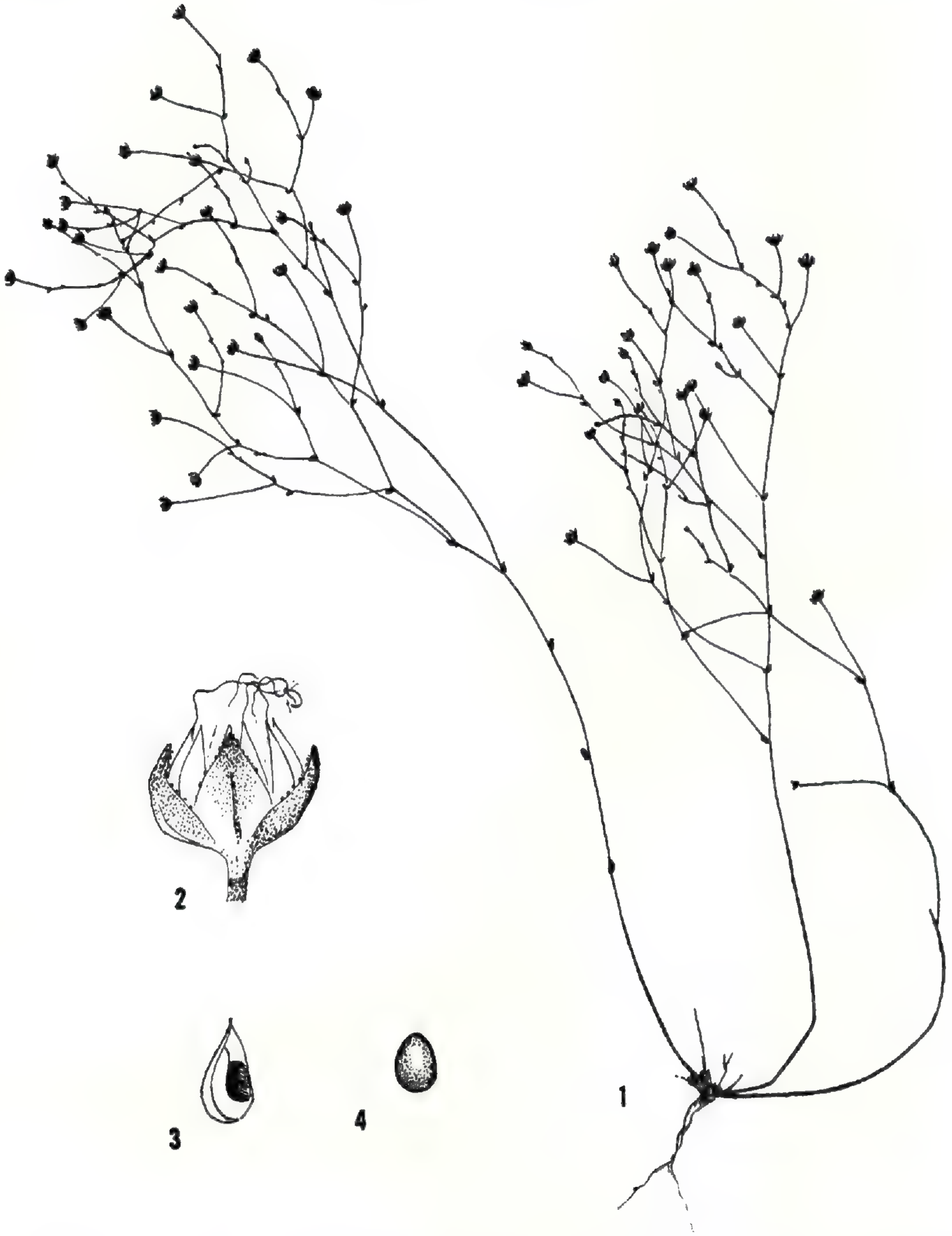
In its fragile appearance and diminutive floral parts it resembles species of *Hesperolinon*, but there is no evidence that it is closely related to that Pacific Coast genus. *Linum modestum* clearly belongs to the portion of the genus represented by the widespread *L. schiedeanum*, but its exact position in relation to those species must await a reevaluation of that whole complex. The slender wiry stems, rather elongate fruiting pedicels and ample inflorescence provide a distinctive habit which, together with the diminutive leaves and floral parts and the absence of stipular glands, serves to separate this species from any other in the region.

Linum modestum C. M. Rogers, sp. nov.

Herba perennis, parva, glabra; caulis tenuis; folia 3.5 mm longa, 1.3 mm lata; sepala 1.7-1.8 mm longa; petala 3-3.5 mm longa; fructus 1.5-1.6 mm longus, dimetiens 1.7 mm. Lino schiedeano affinis.

Perennial herb, 15-18 cm tall, glabrous throughout, branched at the base and in the inflorescence; stem dark purple, slender, wiry; leaves (the lower mostly gone in the specimens available) sessile, 1-nerved, the larger 3.5 mm long, 1.3 mm wide, the lower in whorls of 4, the upper alternate, the uppermost with conspicuous marginal glands, but otherwise all entire; stipular glands none; floral bracts 2 mm or less long, subcordate with marginal glands; inflorescence of few to numerous slender branches, these spreading from main stem at an angle of about 40°; pedicels slender, the lowermost up to 12 mm long in fruit; sepals 5, lanceolate to ovate, blunt to subacute, up to 1.7-1.8 mm long, the margins glandular toothed, those of the inner sepals very sparsely so; petals 5, about 3-3.5 mm long, lemon yellow, without basal pilosity; stamens 5, about 2 mm long; stamen tube very short, with a few hairs or slender lacerations near bases of the filaments; staminodia very small or none; anthers slender, pale, 0.6 mm long; fruit glabrous, broadly ovate, pointed, 1.5-1.6 mm high, about 1.7 mm in diameter, easily crushed, freely dehiscent into 10 segments; false septa incom-

[1]Contribution No. 119 from the Department of Biology, Wayne State University, Detroit, Michigan.



Figs. 1-4. *Linum modestum*. Fig. 1. Habit × ¾. Fig. 2. Fruit × 7.5. Fig. 3. Carpel × 7.5. Fig. 4. Seed × 7.5.

plete; true septa sparsely ciliate; styles 5, separate, contorted soon after anthesis, about 1.6-1.7 mm long; stigmas capitate; seeds 10, pale brown, shining, ovate-elliptic, 0.8 mm long, 0.5 mm wide.

Known only from the type collection.

Type: *F. W. Pennell 16976*, June 26, 1934. Side of arroyo, altitude 1900-2000 m, Pablillo, south of Galeana, Nuevo León, Mexico (US).

POTENTILLA ROBBINSIANA IN THE WHITE MOUNTAINS OF NEW HAMPSHIRE

Of the distinctive alpine flora of the higher mountains of New Hampshire, *Potentilla Robbinsiana* Oakes is probably the most interesting species. It is the only alpine plant endemic to New Hampshire, and is rare in that state. Most other alpines occur on Mt. Katahdin in Maine and also in the arctic. An exception is *Geum Peckii* Pursh, which, although common in alpine regions of New Hampshire and occasional on wet lowland rocks, is known nowhere outside the state except for Brier Island, Nova Scotia.

Potentilla Robbinsiana has been known in the Presidential Range since 1863. It occurs on a small, stony, terraced area near the base of Mt. Monroe. It is represented from this station in a number of herbaria. The tabulation follows: Gray Herbarium, twenty sheets; New England Botanical Club, seven (one erroneously labeled as from Tuckerman Ravine); Jesup Herbarium, five; Pringle Herbarium, eight; University of New Hampshire Herbarium, two. Most of the sheets contain a number of plants, and the usual collecting procedure was to uproot the plant. The original Crawford Bridle Path went through the middle of the station; the present foot path goes to the south of it. In spite of heavy collecting and probable former damage from horses, the colony seems to be holding its own. The plants are small and inconspicuous, but during the flowering season it is easy to find a considerable number scattered throughout the area.

In Franconia Range, the situation is strikingly different. It was first collected from this range by Endicott in 1897 and from a different station by Fernald in 1915. The two stations are three quarters of a mile apart. Since 1915 there have been no collections, and surveys of the area by botanists and naturalists have led to the conclusion that both colonies were extinct. In 1961 and 1963, I made extensive searches of the areas where the colonies were indicated to occur. The 1961 search, concentrated on the

north colony, disclosed nothing, but in 1963, in company with Dr. Harry McDade, an able naturalist of Littleton, N. H., I relocated the southern colony. Only two clumps of the plants were observed, one about three inches in diameter and consisting of sixty plants, the other about one inch in diameter and consisting of six plants. An exhaustive search of the small area suitable for the species revealed no other plants, and, as this was the height of the flowering season, it seems unlikely that any were overlooked.

It is clear that the situation in the Presidentials is markedly different from that in the Franconias. In the former range, the plant is flourishing and perhaps expanding; in the latter, it is on the verge of extinction. There are two possible explanations of this situation.

First, although the alpine area of the Franconia Range is quite large, there are very few suitable sites for *Potentilla.* It evidently can not stand competition with other plants and grows either on bare gravel or in crevices in rocks on decaying mosses. The gravels in the Franconias are apparently of recent origin, unstable, and subject to erosion. Some apparently suitable gravels are near enough to the trail so that they suffer damage from hikers. The clumps of decaying mosses are infrequent, and the chances of a seed reaching them must be small.

Another adverse factor is undoubtedly overzealous collecting by botanists. The attitude of many of the early collectors is well summed up by Joseph Churchill (1901) in writing of the collecting of *Saxifraga stellaris* L. var. *comosa* Poir., a plant now close to extinction on Mt. Katahdin: "Now we all knew that somewhere near the summit 'on wet rocks' there had been collected by Scribner in 1873 *Saxifraga stellaris* var. *comosa* . . . . And to Williams is due the credit of first finding her, and of tearing her ruthlessly from her damp bed under the dark rocks. Being thus advised, however, the others soon found victims in similar unwholesome retreats and though the supply was limited, our Club and private herbaria at least will have a satisfactory representation of the rarity." The standard

method of collecting *Potentilla* was to uproot it. This probably was the cause of the extirpation of one of the Franconia stations.

The origin of this plant is an interesting puzzle. With two exceptions, all members of the alpine flora of the White Mountains also occur in the Arctic. Presumably, they were part of a widespread pre-Pleistocene Arctic flora, and migrated southward during the glaciations. *Potentilla,* the only New Hampshire endemic, may have had a different origin; at least there is no evidence that it was part of a pre-Pleistocene flora. Fernald, in Gray's Manual, in his description of the plant, states, "anomalous species with some characters of one series but with style of another." Polyploidy and apomixis are known to be common in the genus. Stebbins (1950) points out the close relationship between hybridization, apomixis and polyploidy, these processes forming what he designates as an agamic complex. He also states that agamic complexes are particularly well adapted to colonizing new, unstable environments, such as those that have been subject to glaciation. Thus, there is a possibility that *Potentilla Robbinsiana* is an apomictic polyploid of hybrid origin.

To investigate this possibility, cytological studies and emasculation experiments would be necessary. It obviously would be undesirable to remove any *Potentilla* from the Mt. Monroe station. Furthermore, regulations of the White Mountain National Forest prohibit this. There is, however, good evidence that the plant spreads readily by seeds, since it is still flourishing at this station in spite of 100 years of collecting. Thus, a suitable procedure for a botanist wishing to investigate the problem would be to collect seeds and grow them in some lowland station. The same procedure might well be followed in the case of other rare species. Over-collecting by some of the early botanists has apparently destroyed stations of certain rare plants. Contemporary botanists certainly would not wish to follow their example.

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LITERATURE CITED

CHURCHILL, J. 1901. A Botanical Excursion to Mount Katahdin, Rhodora 3: 159.

FERNALD, M. L. 1950. *Gray's Manual of Botany*, 8th Edition, Am. Book Co.

STEBBINS, G. L., JR. 1950. *Variation and Evolution in Plants*, Columbia University Press, New York.

A FLORA OF NORTHERN NEW HAMPSHIRE[1]

This is a thoroughly revised and enlarged edition of the Vascular Flora of Coos County, N. H., published in 1924. However, there are so many additions to the flora, changes in classification, revised statistics, and so much new material in the introduction, that this, in the words of the author, should be regarded as "essentially a new work." Professor Pease died before the actual publication, although he had completed the manscript. The retyping, editing, index, and proofreading were done by Dr. Stuart K. Harris and Mr. Ralph C. Bean. Without their many hours of painstaking labor, the publication of the work in its excellent form would not have been possible.

A total of 1689 species, varieties and forms are treated, the nomenclature following the eighth edition of Gray's Manual. The bulk of the work consists of citations of these taxa from representative localities in the county. In the case of the common species, citations are made from 10 to 20 of the 43 townships and grants of which the county is composed; for rare species all localities are cited. Thus, the work gives an excellent presentation of the distribution of the plants, especially inasmuch as information on habitat and state of abundance are included. The citations in all except a very few cases are supported by specimens, principally in the herbarium of the New England Botanical Club, but to a lesser extent in the Gray Herbarium, the Herbarium

[1]A Flora of Northern New Hampshire by Arthur Stanley Pease, New England Botanical Club, Cambridge, Mass. 278 pages + 2 maps and index, 1964. $4.00

of the University of New Hampshire, and others. The collector's name, collection number if any, and year of collection are given. Professor Pease explored and collected in Coos County with tireless energy from 1895 to 1962 inclusive, and it can be safely assumed that there is very little of significance that has escaped his notice. Except for some cases in the perplexing genera *Rubus* and *Crataegus*, he has identified or checked the identification of the plants, and, as he was noted for being an able and careful taxonomist, there should be very few errors.

Several features of the work will be of interest to the general reader. There is a comprehensive introduction, including a geological section, a discussion of floristic conditions, and a history of botanical investigations extending back for nearly 200 years. The catalogue includes a number of rarities such as the first United States station of *Eleocharis nitida* Fern. The only other locality in the country where it is found is in northeastern Minnesota. The Presidential Range possesses an unusual and distinctive alpine flora. The catalogue contains a definitive list of this flora along with records of all significant collections and also habitat data. Thus, it will be a basic reference for anyone studying the plants of the Presidentials.

There is little to criticize in the work. In some cases there appear to be an excessive number of citations, with too many duplicates from the same locality. A question might be raised as to whether casual escapes and railroad waifs form an actual part of the flora of the county. If so, it must be regarded as in a state of continual change, subject to the whims of gardeners and railroad shippers. All introduced plants are in bold type, however, so the reader can reach his own conclusions.

The book is a valuable contribution to the botanical literature on the flora of northeastern United States, and belongs in the library of all concerned with the study of plants in this region.

FREDERIC L. STEELE
ST. MARY'S-IN-THE-MOUNTAINS
LITTLETON, N. H.

ADDITIONS TO THE FLORA OF THE WOLF ISLANDS, NEW BRUNSWICK FOR 1964[1]

A. R. Hodgdon and Radcliffe B. Pike

We made brief visits to the Wolves on July 1 and September 19, 1964. On our earlier trip we were accompanied by Professor Wesley N. Tiffney of Boston University and his son W. N. Tiffney, Jr., their principal objective being to collect samples for the study of the soil fungi of the islands.

Leaving the mycologists to their work, we decided to explore the bog at Southwest Cove on East Wolf. The barrier beach there was breached during a recent violent storm. This must have been an unusual event, for black spruces of great age were killed by flooding with salt water, and the beach itself was completely rearranged. We wanted to see what kinds of plants grew in the boggy area that flanks the barrier pond and extends well back from it. On one side of the pond where the spruces had been killed, there were relatively open areas quite free from mosses and other bog vegetation. Here were occasional plants of *Galium trifidum* and young plants of *Stellaria calycantha*. In one such opening was a small but rather dense matted growth which superficially resembled a *Stellaria*, but which, on close examination, suggested *Montia*. This was later shown to be *Montia lamprosperma* Cham. Its distribution is of considerable interest. Although of occasional occurrence on the coast of Maine from Boothbay to Cutler, it has not been found on Grand Manan nor further to the east in the Bay of Fundy. Except for solitary stations in eastern New Brunswick, Prince Edward Island and Nova Scotia, *Montia lamprosperma*, like so many of the Wolf Island species, is

[1]This research is part of a project entitled "Floristic and Phytogeographic investigations of the Wolf Islands and other islands in the Bay of Fundy" which was supported by grants from the Central University Research Fund of the Graduate School of the University of New Hampshire and the Society of the Sigma Xi. Published with the approval of the Director of the New Hampshire Agricultural Experiment Station as Scientific Contribution No. 357.

of strong boreal or even arctic affinity. So far as the pattern of its local distribution is concerned, it is an added example of the "Passamaquoddy Flora."

On September 19th, we revisited the bog at Southwest Cove and obtained excellent specimens of *Galium trifidum* L. var. *halophilum* Fern & Wieg. We were surprised to find typical *G. trifidum* in some abundance growing among plants of the variety. There was a noticeable difference in time of flowering of the two when growing together; *Galium trifidum* var *trifidum* was well along in its fruiting, while plants of var. *halophilum* were hardly beginning to fruit. No differences in fleshiness seemed to be evident, perhaps because both varieties were growing under the same conditions.

In a glade opening in the spruce forest within about fifty feet of the bog at Southwest Cove, but on somewhat higher land, we found a few specimens of *Aster Blakei* House. Because of extensive field experience with the plant, we are convinced that *A. Blakei* is indeed a hybrid of *Aster acuminatus* Michx. and *A. nemoralis* Ait., both of which occur on East Wolf Island. Here it occupies a niche somewhat intermediate between the usual habitats of its two putative parents.

Several times in earlier years we had seen clumps of *Anaphalis margaritacea* (L.) C. B. Clarke. Mostly these have been too immature for critical identification, but there seemed to be considerable variation in such characteristics as shape of leaves and condition of pubescence. On our September visit, we came upon a clone of Pearly Everlasting ing in the bushy field at the eastern end of East Wolf. These handsome plants had particularly noticeable bright green leaves and reminded us of garden plants we had seen of the same variety in Scotland earlier in the summer. It is the var. *margaritacea* of relatively northern or even subalpine situations. It has not been found on Grand Manan. Weatherby and Adams in the "List of the Vascular Plants of Grand Manan" (Contr. Gray Herb. **CLVIII:** 72, 1945) made the following comment about *Anaphalis margaritacea*: "The

Grand Manan plant belongs with var. *intercedens* Hara." Roland, in "The Flora of Nova Scotia" (Proc. Nova Scot. Inst. **XXI** part 3:500, 1945), mentions the typical variety as being scattered in northern Cape Breton and not being clearly defined elsewhere in the Province. This, then, is another of the boreal disjuncts of the Wolves, characteristic of Cape Breton, areas about the Gulf of St. Lawrence, northern New England and northward, most of which are absent from Grand Manan and the southern part of Nova Scotia.

One of the main objectives of our September trip was a further close examination of the area where we had collected our recently described *Epilobium nesophilum* Fern. var. *lupulinum* Hodgdon & Pike. We did find a heterogeneous population of Epilobiums there, but nothing matching our new variety which presumably matures early and had gone by. When we first discovered this locality, the only Epilobiums found were specimens of the var. *lupulinum*. On this recent visit, we were confronted by a totally different array of plants. Of this assemblage we have been able to sort out *Epilobium palustre* L. var. *palustre* and *E. palustre* var. *grammadophyllum* Haussk., both of which are new to the Wolf Islands list. Later in the day we found var. *grammadophyllum* also on South Wolf Island. In general, the populations of *E. palustre* were variable. Also, there were some rather unusual individuals, perhaps of hybrid origin between *E. palustre* and other species.

Two other new species for the Wolf Islands are *Polygonum Persicaria* L. and *Rubus hispidus* L., both of which were found in the cleared area at the eastern end of East Wolf.

In summary, the following taxa are added to the list of vascular plants of the Wolf Islands resulting from our collecting in 1964:

Polygonum Persicaria L. (East Wolf)
Montia lamprosperma Cham. (East Wolf)
Rubus hispidus L. (East Wolf)
Epilobium palustre L. var. *palustre* (East Wolf)
E. palustre L. var. *grammadophyllum* Haussk. (East Wolf, South Wolf)

Galium trifidum L. var. *halophilum* Fern. & Wieg. (East Wolf)
Aster Blakei House (East Wolf)
Anaphalis margaritacea (L.) C. B. Clarke var. *margaritacea* (East Wolf)

Some time ago we published a tabular inventory of the vascular flora of the Wolves, island by island (Rhodora **65**:82-96, 1963). Eight more species were reported resulting from our field work in 1963 (Rhodora **66**:61-62, 1964). We described two new varieties from the Wolves still more recently (Rhodora **66**: 140-155, 1964), and in this paper eight others are reported for the first time.

Table 1
Total taxa recorded — 332

	East Wolf	South Wolf	Fat Pot	Flat Wolf	Gull Rock
Comparative areas of islands	42	12	6	3	1
Taxa recorded	297	168	117	96	35
Ratio of taxa to area	7	14	19.5	32	35

Recently (Rhodora **66**:140-155, 1964) we discussed the phytogeographic relationships of the Wolf Island Flora, contrasting its pronounced boreal character to the much weaker boreal aspect of Grand Manan. We pointed out that the Wolf Islands had 43 boreal taxa, of which 10 species were shared with Grand Manan. *Epilobium palustre* var. *palustre*, which is found on both islands, should be added, making 11 shared species. Both *Montia lamprosperma* and *Anaphalis margaritacea* var. *margaritacea* from our recent collections, however, are markedly of boreal affinity and are absent from Grand Manan. The Wolf Islands, then, have 46 boreal taxa, of which 11 are shared. The two island groups together have a total of 57 boreal taxa, of which the Wolves now may be seen to have 80.7% while Grand Manan has only 38.6%.

Specimens of the 1964 collections are deposited in the University of New Hampshire herbarium (NHA).

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INDEX TO VOLUME 66

New scientific names and combinations are printed in bold face type

Abrus precatorius 12
Acanthaceae, Sanchezia and Related American 313
Acer rubrum 312, 379
Achillea borealis 152; lanulosa 152; Millefolium 152
Achyropappus anthemoides 72 fig., 73, 75, 307; maritimus 208; woodhousei 290
Acrostichum aureum 9
Aganippea bellidiflora 156; (Compositae-Heliantheae), The Status of 156; dentata 156
Agarum cribrosum 222 Pl., 223, 230
Agave inaguensis, 8, 12; nashii 8
Agropyron repens f. trichorrhachis 62; trachycaulum, var. glaucum 143; var. majus 144
Agrostis nadifolia 277; rosea 277; scabra 380
Ahnfeltia plicata 221, 224
Alaria esculenta 219 Pl., 220, 226, 30
Aletris lutea 380
Alga from Massachusetts, A Rare Blue-green 163
Allium vineale var. compactum 312
Amaranthus dubius 12; viridis 12
Amauria? dissecta 185, 190, 196
Amauriopsis dissecta 179, 190
Amelanchier Bartramiana 141, 146, 147, 153; laevis 141, 146, 153
Amyris balsamifera 19; floridana 19
Anaphalis margaritacea 414; var. angustior 152; var. intercedens 415; yar. margaritacea 414, 416 var. subalpina 152
Anastraphia bahamensis 15; cuneifolia 6, 15
Anchistea virginica 381
Ancylogyne capitata 319; longiflora 335; munita 325; peruviana 323
Andropogon gerardi 166; perangustatus 380; pertusus 11, 273; stolonifer 380; tracyi 381; In the United States, Notes on Paspalum minus and 273
Anemonella thalictroides 312
Antithamnion boreale 224; floccosum 224, 225
Antrophyum alatum 110; brasilianum 112, 113; var. elongatum 112; cajanense 112, 113; callifolium 110; discoideum 112, 113; guayanense 113; Jenmanii 114; latifolium 110; Ledermanii 110; reticulatum 110; subfalcatum 110; subsessile 113; var. elongatum 112
Aphanostephus arizonicus 271; (Compositae), Microchromosomes in 270; c.f. pachyrrhizus 271; ramossissimus 271; ramosus 270, 271; ridellii 271; skirrhobasis 270 fig., 271
Arctium lappa 55
Ardisia escallonioides 19
Arisaema atrorubens f. zebrinum 312; Dracontium 312
Aristida stricta 378; ternipes 11
Arundinaria tecta 381
Asarum canadense 312
Asclepias stenophylla 379
Ascophyllum nodosum 220, 230
Ascyrum hypericoides 379; pumilum 379
Asimina triloba 312
Asparagopsis hamifera 225, 230
Aster acuminatus 414; Blakei 414, 416; eryngiifolius 381; foliaceus 152; nemoralis 414; novi-belgii 62; umbellatus 152; var. pubens 152

Atriplex glabriuscula 146, 154; patula, var. patula 146
Axonopus affinis 380

Baccharis halimifolia 159
Baeria 67; palmeri 309
Bahadur, Bir, Pollen Dimorphism in Heterostyled Oldenlandia umbellata 56
Bahia absinthifolia 70, 74, 76 fig., 77, 80, 83 fig., 84 fig., 181, 182, 185, 292, 293, 295; var. absinthifolia 70, 71 fig.. 75, 78, 79 fig., 80, 81, 82, 83 fig., 84 fig., 85 fig., 183, 187, 292, 293, 294 fig., 295 fig., 296; var. dealbata 69 note, 70, 71 fig., 73, 75, 78, 79 fig., 80, 81, 82, 83 fig., 84 fig., 85 fig., 183, 187, 293, 294 fig., 296, 298, 299 fig.; achillaeoides 307; alternifolia, nom nud 307; ambigua 307; ambrosioides 68, 179, 183, 184, 186, 188, 208, 210 fig., 211 fig.; angustifolia 307; anthemoides 307; arachnoidea 308; aristata 284; artemisiaefolia 308; **autumnalis** 72 fig., 73, 74, 76 fig. 77, 78, 79 fig., 80, 181, 183, 186, 189 fig., 199, 201, 202 fig.; bigelovii 70, 71 fig., 74, 75, 76 fig., 77, 78, 79 fig., 80, 181, 183, 186, 213, 214 fig., 215 fig.; biternata 183, 186, 190, 193, 201, 204, 205 fig., 206; chrysanthemoides 190; (Compositae), A Systematic Study of the Genus 67, 177, 281; confertiflora 308; var. trifida 308; cuneata 308; dealbata 293, 298; depauperata 308; depressa 308; desertorum 308; dissecta 72 fig., 73, 74, 75, 76 fig., 77, 78, 79 fig., 80, 179, 181, 183, 186, 190, 193 fig., 194 fig., 195 fig., 196; var. anisopappa 192, 195 fig., 196; var. dissecta 190; ehrenbergii 301, 305; Gilliesii 308; glandulosa 72 fig., 73, 74, 75, 76 fig., 183, 186, 187, 188, 189 fig., 190, 191 fig., 204; gracilis 308; integrifolia 308; lanata 308; var. achillaeoides 308; var. brachypoda 308; var. grandiflora 308; var. tenuifolia 308; latifolia 308; leucophylla 308; multiflora 309; neomexicana 177 note, 309; nepetaefolia 309; nudicaulis 309; oblongifolia 309; oppositifolia 68, 181, 183, 187, 214 fig., 285, 287, 288 fig., 291, 292; ourolepis 309; palmeri 309; parviflora 309; pedata 72 fig., 73, 74, 75, 76 fig., 77, 79 fig., 80, 183, 186, 188, 189 fig., 190, 201, 204, 206, 207 fig.; pringlei 70, 71 fig., 73, 74, 75, 76 fig., 182, 183, 282 fig., 302, 303, 305, 306 fig.; resinosa 309; rubella 309; schaffneri 69, 72 fig., 73, 74, 75, 76 fig., 77, 79 fig., 80, 181, 281, 282; var. **aristata** 183, 187, 282, 283, 284, 286 fig.; var. schaffneri 183, 186, 281, 282, 283, 284; schkuhrioides 309; sinuata 309; staechadifolia 309; var. californica 309; tenuifolia 308, 309; trifida 309; trolliifolia 309; wallacei 309; woodhousei 179, 181, 182, 183, 187, 214 fig., 287, 290, 291 fig., 292; xylopoda 70, 71 fig., 73, 74, 75, 76 fig., 182, 183, 282 fig., 301, 302, 303, 304 fig., 305, 307
Baldwinia atropurpurea 381; uniflora 381
Bangia fuscopurpurea 220, 225
Banks, Donald J., Chromosome Counts for Paspalum 368; Notes on Paspalum minus and Andropogon pertusus in the United States 273
Baranov, A. I., On the Perianth and Seed Characteristics of Chenopodium hybridum and C. gigantospermum 168

Barbula agraria 15
Beaman, J. H. and A. M. Torres, The Status of Aganippea bellidiflora (Compositae-Heliantheae) 156
Bean, Ralph C., Arthur Stanley Pease 3
Beaudry, J. R., Solidago rupestris and S. canadensis 404
Beetle, A. A., A New Name in Deyeuxia 277
Benitoa occidentalis 63
Betula papyrifera var. cordifolia 140, 146
Befaria racemosa 19
Bontia daphnoides 14
Borreria savannarum 14; thymifolia 15
Bothriochloa pertusa 273
Botrychium simplex 142; var. tenebrosum 142
Braun, Lucy E., Micheliella verticillata in Ohio 275
Buchnera floridana 379
Bursera inaguensis 6

Cacalia graminifolia 383, 396
Caesalpinia ovalifolia 12; reticulata 6
Calamagrostis canadensis 144, 154; var. robusta 144; var. scabra 144; rosea 277
Calder, James A. and Gerald A. Mulligan, The Genus Subularia (Cruciferae) 127
Calea angustifolia 307
Calothrix scopulorum 218, 224, 225, 228
Camassia angusta 16, 17; Notes on Papavar dubium and 16; scilloides 17
Capsella rubella 142
Cardiospermum microcarpum 13
Carduus lecontei 381
Carex angustior 144; canescens 154; var. canescens 144; var. disjuncta 144; var. subloliacea 144; crinita, var. crinita 145; var. gynandra 145; echinata 144; Emmonsii 144; nigra, var. nigra 145; var. strictiformis 145; rostrata, var. rostrata 145; var. utriculata 145
Carphephorus pseudo-liatris 380
Carya ovalis 312
Cassia inaguensis 6; nictitans 379
Ceanothus microphylla 379
Cenchrus incertus 11
Centaurium brittonii 13
Centella erecta 379; repanda 380
Ceramium rubrum 221, 225, 227
Chaetomorpha atrovirens 233; linum 233; melagonium 220, 233
Channell, R. B. and C. W. James, Nomenclatural and Taxonomic Corrections in Warea (Cruciferae) 18; Uzi Nur and Jens Clausen, Viola rafinesquii, The Only Melanium Violet Native to North America 32
Charette, Leopold A., Hydrastis canadensis L. in New England 94
Chenopodium hybridum 168, 170 fig., 171; and C. gigantospermum, On the Perianth and Seed Characteristics of 168; var. gigantospermum 171; gigantospermum 170 fig., 171; salinum 280
Chiococca alba 19; racemosa 19
Chloris polydactyla 11
Chondrus crispus 220, 221, 223, 224, 225, 232, 233
Chorda filum 230; tomentosum 220, 226, 230
Chordaria flagelliformis 226, 230
Chrysocoma graminifolia 382, 396
Chrysoma solidaginoides 20
Cienfuegosia heterophylla 13
Cimicifuga racemosa var. cordifolia 135; rubifolia 135; Kearney in Virginia, Note on 135
Clathromorphum circumscriptum 225
Clausen, Jens, R. B. Channell and

Uzi Nur, Viola rafinesquii, The Only Melanium Violet Native to North America 32
Claytonia caroliniana 136, 137, 138; virginica 136, 137, 138; in Virginia, A Hybrid Population of 136
Cleome cuneifolia 20
Cliftonia monophylla 380
Coccolobis bahamensis 6
Collinsonia canadensis 276; verticillata 275
Conifer Twigs With Deciduous Leaves, A New Method for Mounting Evergreen 216
Coniogramme mexicana 111
Conioselinium chinense 140, 150, 154
Conobea multifida 280; A New Record for Nebraska 280
Conyza canadensis 380
Corallina officinalis 221, 225
Coreopsis angustifolia 381
Cornus florida 312
Craighead, Frank C. and Walton, C. Galinat, Some Observations on the Dissemination of Tripsacum 371
Croton eluteria 13
Culcita coniifolia 111
Cynanchum inaguense 13
Cyperus acuminatus 280; diandra 280; odoratus 11
Cyrilla paniculata 19
Cystoclonium purpureum 226; var. cirrhosum 226

Defilipps, Robert A., Diplotaxis tenuifolia in Illinois and Other Records 54
Delesseria alata 249, 250 note; var. angustissima 242 fig., 247, 250 note; angustissima 236, 244 fig. 245, 247, 249, 250 note; baerii 234, 235, 245, 246, 247 note, 250; var. corymbosa 246; corymbosa 235, 245, 246, 247 note; rostrata 246, 247
Delphinium tricorne 312
Dentaria laciniata 312
Deramus, Rebecca and Joab L. Thomas, The Chromosome Number of Neviusia alabamensis Gray 274
Deschampsia flexuosa 144; var. montana 144
Desmarestia aculeata 231; viridis 231
Desmodium glabrum 12
Deyeuxia, A New Name in 277; **colorata** 277; nardifolia 277; rosea 277
Diamorpha (Crassulaceae), Notes on the Genus 87; cymosa 47, 87, 88, 89, 90; pusilla 88, 90; Smallii 88 fig., 89 90
Dichromena colorata 11; inaguensis 8, 11
Diodia tetragona 379; virginiana 379
Diospyros virginiana 312
Diplachne halei 165
Diplotaxis muralis 54; tenuifolia 54; in Illinois and Other Records 54
Disporum maculatum 275
Dryopteris celsa 255, 262, 263; × intermedia 263; clintoniana 255; × spinulosa 263; cristata × intermedia 255; dilatata × intermedia 262; × marginalis 262; goldiana 256, 257 Pl., 258 fig., 260, 261 Pl., 262, 263, 264 fig., 265, 266; × intermedia 255, 256, 257 Pl., 258 fig., 260, 261 Pl., 262, 263, 264 fig.; A Natural Woodfern Cross of Noteworthy Morphology 255; × spinulosa 262, 263; intermedia 256, 257 Pl., 258 fig., 259, 260, 261 Pl., 263, 264 fig., 265, 266; × marginalis 262; × spinulosa 255; × separabilis 263; spinulosa 255, 259; wherryi 255, 263; × intermedia 263
Dunbar, Henry F. and Richard A.

Howard, Additions to the Flora of Inagua, The Bahamas 6
Duncan, Wilbur H., New Elatine (Elatinaceae) Populations in the Southeastern United States 47
Dyssodia micropoides 308

Echinocloa crusgalli 280
Echinodorus berteroi 11; cordifolius 11
Echium vulgare 55
Ectocarpus tomentosoides 231
Elachistea fucicola 231
Elatine americana 47, 50, 51, 52; brachysperma 47, 50, 51, 52; (Elatinaceae) Populations in the Southeastern United States, New 47; minima 47, 50, 51, 52; rubella 52; triandra 48 fig., 50, 51, 52, 53; var. americana 52; var. andina 51, 52, 53; var. brachysperma 50, 53; var. genuina 51 note, 53
Eleocharis acicularis 127; atropurpurea 161; compressa 162; geniculata 11; macrostachya 161; nitida 412; rostellata 162; Smallii 161; wolfii 162
Ellison, William L. A Systematic Study of the Genus Bahia (Compositae) 67, 177, 281
Empetrum nigrum 62; Fasciation in 62
Enteromorpha linza 233
Epilobium nesophilum 150; var. **lupulinum** 149, 150, 415; var. sabulonense 149, 150; palustre 415; var. grammadophyllum 415; var. palustre 415, 416
Erianthus alopecuroides 268, 269 Pl. coarctatus 380; giganteus 380; —, An Unusual 268
Erigenia, A Genus New to Oklahoma 311; bulbosa 311
Eriocaulon lineare 380
Erigeron strigosus 380
Eriophyllum 67; absinthifolium 292; ambiguum 307, 309; ambrosioides 208; bigelovii 213; biternata 201; chrysanthemoides 190; confertiflora 308, 309; lanatum var. achillaeoides 307, 308; var. arachnoideum 308, 309; var. cuneatum 308; var. grandiflorum 308; var. integrifolium 308, 309; var. lanatum 308; oppositifolium 285; pedatum 204; staechadifolium 308, 309; wallacei 309; woodhousei 290
Erithallis fruticosa 15; odorifera 15
Ernodea nashii 15
Eryngium yuccifolium 380
Eupatorium anomalum 379; capillifolium 379; leucolepis 379; verbenaefolium 380
Euphorbia corollata 377, 379; lecheoides 8
Euphrasia americana 151; canadensis 151; Randii 151
Euthora cristata 221, 226, 227
Evans, A. Murray and W. H. Wagner, Jr., Dryopteris goldiana × intermedia — A Natural Woodfern Cross of Noteworthy Morphology 255
Evers, Robert A., Illinois Flora: Notes on Leptocloa and Lycopodium 165

Fagus grandifolia 176
Ferns, Taxonomic Notes IV. Some American Vittarioid 110
Festuca rubra, var. commutata 62
Fimbristylis vahlii 161
Flaveria bidentis 15
Flora of Stoughton, Publication Date for 31
Florestina 67
Fucus alatus γ angustissimus 235; edentatus 219 Pl., 220, 229, 231, 232; vesiculosus 218, 220, 230, 231

Gaillardia 67

Galinat, Walton C. and Frank C. Craighead, Some Observations on the Dissemination of Tripsacum 371
Galium labradoricum 151, 154; trifidum 413, 414; var. halophilum 414, 416; var. trifidum 414
Garberia heterophylla 19
Gaylussacia dumosa var. Bigeloviana 141
Gelsemium rankinii 379; sempervirens 159
Geocaulon lividum 61, 62, 146, 154
Gentiana andrewsii 403; **austromontana** 402, 403 Pl., 404; A New Species from the Southern Appalachians 402; clausa 402, 403 Pl., 404; decora 403, 404
Georgia, Floristic Changes within Pitcher Plant Habitats in 375
Gerardia fasciculata 379; pauperula 380; skinneriana 380
Geranium carolinianum 379
Geum Peckii 408
Gigartina purpurascens γ rostrata 235; stellata 220, 226
Gillett, George W., Genetic Barriers in the Cosmanthus Phacelias (Hydrophyllaceae) 359
Gnaphalium peregrinum 380
Gochnatia bahamensis 15
Gratiola neglecta 379; ramosa 379
Gutierrezia ? 309
Gyrotheca tinctoria 379

Halosaccion ramentaceum 219 Pl., 220, 226, 230, 231
Haplopappus divaricatus 63, 64 fig., 65, 271; Chromosome Numbers in Races of 63; gracilis 271; occidentalis 63
Harms, Larry J., New Records and Notes on Plants of Kansas 161
Harvill, A. M., Jr., Magnolia grandiflora in Gray's Manual Range 159
Heiser, C. B. and D. M. Smith, Species Crosses in Helianthus II. Polyploid Species 344
Helenium 67; brevifolium 380; oppositifolium 285; tenuifolium 380; vernale 380
Helianthus: II. Polyploid Species, Species Crosses in 344; annuus 344, 345, 350, 351, 354, 355, 356, 357; attenuatus 346 note; canus × angustifolia 352; californicus 349; ciliaris 346, 349; debilis 353; × floridanus 352; × occidentalis 353 Pl.; decapetalus 345, 347 fig., 348, 354; × annuus 350, 351; × debilis ssp. cucumerifolius 350; × debilis ssp. hirtus 350; × laevigatus 346; 4N × resinosus 6N 352; × strumosus 346; divaricatus 354; giganteus × microcephalus 348; hirsutus 348, 354; × annuus 350; × decapetalus 347 fig.; × debilis ssp. cucumerifolius 350, 351; × smithii 346; 4N × tuberosus 6N 352; maximiliani × 2N decapetalus 348; microcephalus 346 note, 352; × giganteus 347 fig., 348; niveus 352; nuttallii 353; occidentalis 353; parviflorus 346 note; var. attenuatus 346 note; resinosus 349; 6N × decapetalus 4N 352; × schweintzii 349; 6N × smithii 4N 352; × strumosus 349; × tuberosus 347 fig., 349; rigidus 349; × strumosus 349; × tuberosus 349; schweintzii 349, 350; × smithii 347 fig.; 6N × smithii 4N 352; × tuberosus 349, 350; **smithii** 346 note, 348; 4N × strumosus 6N 352; strumosus 346, 348, 349, 350, 355; × annuus 347 fig., 350; × hirsutus 346; × tuberosus 349; tomentosus 349 note; tuberosus 344, 345, 349, 350,

351, 354, 355, 356, 380; × annuus 344, 351, 354, 356; undulatus 381
Heliogenes longifolia 156, 157
Heliotropium diffusum 6, 14; inaguense 6, 14; nashii 8, 14
Hermionitis brasiliana 113; cajanensis 112, 113; reticulata, var. brasiliansis 113
Hieracium florentinum 61; pilosella 61; pratense 142
Hildenbrandtia prototypus 226
Hill, A.F., Charles Schweinfurth and Frank C. Seymour, Publication Date for the Flora of Stoughton 31
Hodgdon, A. R., Flora of Missouri (Review) 92; and R. B. Pike, Additions to the Wolf Islands Flora, 1963 61; Additions to the Flora of the Wolf Islands, New Brunswick for 1964 413; Flora of the Wolf Islands, New Brunswick, Part II 140
Hottonia palustris 56
Houstonia caerulea 379
Howard, Richard A. and Henry F. Dunbar, Additions to the Flora of Inagua, the Bahamas 6
Hunnewell 1880-1964, Francis Welles 97
Hybanthus concolor 312
Hydrastis canadensis in New England 94
Hydrophyllum virginianum 312
Hymenopappus 67; glandulopubescens 187
Hymenothrix 67
Hymenoxys 67; odorata 74
Hypericum virginicum 149; var. Fraseri 149
Hypoxis hirsuta 379; juncea 379

Ilex myrtifolia 379; verticillata 176; vomitoria 159
Illinois Flora: Notes on Leptocloa and Lycopodium 165
Ilysanthes monticola 379
Inagua, The Bahamas, Additions to the Flora of 6
Iresine inaguensis 8, 12
Iris virginica var. Shrevei 312
Itea virginica 380

Jaegeria bellidiflora 156, 157; pedunculata 157; purpurascens 157
James, C. W. and R. B. Channell, Nomenclatural and Taxonomic Corrections in Warea (Cruciferae) 18
Jasminum fluminense 13
Jatropha gossypifolia 13
Johnson, R. Roy and Edwin B. Smith, Microchromosomes in Aphanostephus (Compositae) 270
Jones, Samuel B., Jr., Taxonomy of the Narrow-leaved Vernonia of the Southeastern United States 382
Juglans nigra 312
Juncus balticus var. littoralis 141; effusus var. compactus 145; var. Pylaei 145; var. solutus 145; polycephalus 161; validus 161
Juniperus communis var. depressa 141; horizontalis 141

Kansas, New Records and Notes on Plants of 161
Koellia flexuosa 379; hyssopifolia 380
Kuhnia eupatorioides var. angustifolia (Compositae), Application of the Name 160; var. corymbosa 160; var. eupatorioides 160; var. ozarkana 160; var. pyramidalis 160

Lachnocaulon glabrum 379
Lamb, I. Mackenzie and Martin H. Zimmermann, Marine Vegetation of Cape Ann, Essex County, Massachusetts 217

Laminaria agardhii 220, 231, 232; digitata 220, 232; longicruris 220, 232
Lantana balsamifera 6
Lasthenia 67
Lathyrus japonicus var. pellitus 62; palustris var. linearifolius 149; var. pilosus 149
Leathesia difformis 232
Lemaire, Robert J., Conobea multifida; A New Record for Nebraska 280
Leonard, Emery C. and Lyman B. Smith, Sanchezia and Related American Acanthaceae 313
Leptochloa and Lycopodium, Illinois Flora: Notes on 165; paniculoides 165
Leptopoda helenium 381
Liatris fruticosa 19; umbellata 396
Limosella africana 127
Linaria canadensis 379
Lindera Benzoin 312
Linum **coahuilense** 278 fig., 279; —, A New Species from Northern Mexico 278; grandiflorum 56; longipes 279; mexicanum 279; **modestum** 406, 407 fig.; A New Species from Mexico 406; rigidum 279; rupestre 279; schiedeanum 406; sulcatum 279
Liquidambar styraciflua 159, 380
Liriodendron tulipifera 379
Lobelia lucayana 15; nuttallii 379
Lomatogonium rotatum 154; var. americanum 151
Lonicera villosa 152; var. calvescens 152; var. Solonis 152; var. tonsa 152
Loxogramme mexicana 111; Salvinii 111
Loxothysanus sinuatus 309
Luzula multiflora 145; var. acadiense 145; var. comosa 145; var. multiflora 145
Lycium spathulifolium 6
Lycopodium annotinum 142; var. alpestre 142; var. pungens 142; complanatum var. flabelliforme 166; Illinois Flora: Notes on Leptochloa and 165; lucidulum 166; pinnatum 381; porophillum 165, 166

Magnolia grandiflora 159; in Gray's Manual Range 159; tripetala 275
Marilaunidium jamaicense 13
Marsilia 9; nashii 6, 10, 11; quadrifolia 161; tenuifolia 10
Massachusetts, Marine Vegetation of Cape Ann, Essex County 217; A Rare Bluegreen Alga from 163
Mayaca aubletii 380; fluviatilis 379
Meibomia mollis 12
Melanthium virginicum 380
Meliococca bijuga 13
Meliococcus bijugatus 13
Membranoptera alata 226, 238, 241, 242 fig., 244, 245, 249
Metastelma inaguense 13
Micheliella verticillata 275, 276; in Ohio 275
Missouri, Flora of (Review) 92
Monostroma oxyspermum 233; pulchrum 233
Montia lamprosperma 413, 415, 416
Mulligan, Gerald A. and James A. Calder, The Genus Subularia (Cruciferae) 127
Myrica cerifera 159; Gale 145

Nama jamaicense 13
Nashia inaguensis 8, 14
Neviusia alabamensis 274; Gray, The Chromosome Number of
New Hampshire, A Flora of Northern (Review) 411
Nostochopsis lobatus 163 fig., 164
Nur, Uzi, Jens Clausen and R. B. Channell, Viola rafinesquii, The

Only Melanium Violet Native to North America 32

Oklahoma, Podophyllum peltatum f. Deamii From Bryan County 167
Oldenlandia angustifolia 57; umbellata 56, 57, 58 Pl.; Pollen Dimorphism in Heterostyled 56
Opuntia nashii 6
Ornduff, Robert and James D. Perry, Reproductive Biology of Piriqueta caroliniana (Turneraceae) 100
Orochaenactis thysanocarpha 309
Osmorhiza longistylis var. villicaulis 312
Ostrya virginiana var. lasia 312
Oxalis filipes 379
Oxytris crocea 380

Palafoxia 67
Panicum albomarginatum 380; anceps 380; combsii 381; condensum 380; consanguineum 380; ensifolium 380; hemitomon 381; lancearium 380; leucothrix 380; longiligulatum 380; melicarium 381; scabriusculum 380; scoparium 380; trifolium 380; virgatum 380
Pantoneura angustissima 235, 236, 237 fig., 238, 241, 242, 243 fig., 244 fig., 245, 247, 249, 250, 252; baerii 221, 222 Pl., 223, 227, 235, 236, 238, 239 Pl., 240 fig., 241 fig., 243 fig., 244, 245, 246, 247, 248 fig., 249, 250, 251, 252; corymbosa 235, 245; plocamioides 234, 235; rostrata 235, 245
Papavar dubium 16; and Camassia angusta, Notes on 16
Parkinsonia aculeata 12
Paspalum blodgettii 369 fig.; caespitosum 369 fig.; Chromosome Counts for 368; curtisianum 381; fimbriatum 369, 370; fluitans 369 fig., 370; laeve 368, 369 fig., 370; laxum 11; longipilum 380; minus 273; and Andropogon pertusus in the United States, Notes On 273; molle 11; poirettii 11 setaceum 380; urvillei 380
Passiflora suberosa 19; Warei 19
Pease, Arthur Stanley 3
Peperomia leptostachya 20
Perityle 67
Perry, James D. and Robert Ornduff, Reproductive Biology of Piriqueta caroliniana (Turneraceae) 100
Persea borbonia 159
Petalonia fascia 220, 232
Phacelia bipinnatifida 359; dubia 359, 360, 362, 363 fig., 364, 366; fimbriata 359, 360, 362, 363 fig., 364, 366; franklinii 367; (Hydrophyllaceae) Genetic Barriers in the Cosmanthus 359; gilioides 359, 360, 362, 363 fig., 364, 365, 366, 367; glabra 359; hirsuta 359, 360, 362, 363 fig., 364, 365, 366, 367; laxa 359, 360, 362, 363 fig., 364, 365, 366; linearis 367; maculata 359, 360, 362, 363 fig., 364, 366; patuliflora 359, 360, 362, 363 fig., 364, 365, 366; var patuliflora 364, 365; var. teucriifolia 364; platycarpa 359, 360, 362, 363 fig., 364, 366; pulcherrima 359, 360; purshii 359, 360, 361, 362, 363 fig., 364, 365, 366, 367; ranunculacea 359; strictiflora 359, 360, 362, 363 fig., 364, 365, 366; var. lundelliana 364, 365; var. robbinsii 364
Philodendra Ex Regione Amazoniae Nova, Plantae Columbianae, XVII 118
Philodendron **craspedodromum** 118, 119 fig., 120, 122; **dyscarpium** 122, 126; **haematinum** 120, 121 fig., 122, 123 Pl., 126; **remi-**

folium 120, 122, 124, 125 fig., 126
Phlox divaricata, var. Laphamii 312; pilosa 379
Phycodrus rubens 227
Phyllophora brodiaei 222 Pl., 223, 227
Phymatolithon laevigatum 227
Physostegia denticulata 380
Phytolacca americana 379
Picradeniopsis dealbata 298; oppositifolia 286; woodhousei 179, 290
Pieris phillyreifolia 380
Pike, R. B., Fasciation in Empetrum nigrum 62; Plant Pressing with Plastic Sponges 172; and A. R. Hodgdon, Additions to the Wolf Islands Flora, 1963 61; Additions to the Flora of the Wolf Islands, New Brunswick for 1964 413; Flora of the Wolf Islands, New Brunswick, Part II 140
Pilea microphylla 12
Pine, Needle Number in Red 27
Pinus banksiana 29; elliottii 375 nigra 29; palustris 30, 379; ponderosa 28; resinosa 27, 28; serotina 375, 380; taeda 30, 159, 379
Piper leptostachyon 20
Piriqueta caroliniana 100, 101 fig., 102, 103, 105, 106, 107, 108, 379; var. caroliniana 100, 103, 104, 108; cisfoides 107, 108; (Turneraceae), Reproductive Biology of 100
Pitcher Plant Habitats in Georgia, Floristic Changes within 375
Pithecolobium flavovirens 6
Plantago juncoides var. decipiens 151; var. glauca 151; var. laurentiana 151; virginica 14, 379
Platyschkuhria integrifolia 308, 309; oblongifolia 309; **ourolepis** 309
Plectonema battersii 224
Pluchea foetida 380
Plumbago floridana 19; scandens 19
Plumiera inaguensis 6; Plumeria obtusa var. sericifolia 13; sericifolia 13
Plummer, Gayther L. and Thomas Pullen, Jr., Floristic Changes within Pitcher Plant Habitats in Georgia 375
Podophyllum peltatum 167; f. Deamii 167; — from Bryan County, Oklahoma 167
Polygala wightiana 13
Polygonatum canaliculatum 312
Polygonum cespitosum var. longisetum 54; hydropiperoides 377, 379; longisetum 54; Persicaria 415
Polyides caprinus 223, 227
Polypremum procumbens 13
Polysiphonia flexicaulis 228; lanosa 228; nigrescens 228; urceolata 228
Polytaenium brasilianum 112, 113; cajanense 112, 113; discoideum 112, 113; guayanense 112, 113; lanceolatum 110; lineatum 110; Jenmanii 114
Populus deltoides 280
Porphyra linearis 218, 228; miniata 229; umbilicaulis 228, 229
Portulaca gagatosperma 8
Potentilla Robbinsiana 408, 410; in the White Mountains of New Hampshire 408
Pressing with Plastic Sponges, Plant 172
Pringle, James S. and Aaron J. Sharp, Gentiana austromontana, A New Species from the Southern Appalachians 402
Psychotria lanceolata 19; nervosa 19
Pteropsis vittarioides 116
Ptilimnium capillaceum 379
Ptilota serrata 223, 229

Puccinellia laurentiana 143; var. laurentiana 62; paupercula var. alaskana 62, 143; var. paupercula 143
Pullen, Thomas, Jr. and Gayther L. Plummer, Floristic Changes within Pitcher Plant Habitats in Georgia 375
Punctaria plantaginea 232
Pycnoporus sanguineus 15
Pylaiella littoralis 232
Pyrrhopappus carolinianus 380
Pyrus americana 61; decora 61

Quercus Muehlenbergii f. Alexanderi 312; rubra var. borealis 312

Ralfsia fungiformis 232
Ramsey, Gwynn W., Note On Cimicifuga rubifolia Kearney in Virginia 135
Ranunculus laxicaulis 379
Ratibida (Compositae) from Mexico, A New Species of 267; columnifera 267, 268; **latipalearis** 267, 268; mexicana 267, 268
Rhabdadenia biflora 13; paludosa 13
Rheum Rhaponticum 142
Rhexia filiformis 380; stricta 380
Rhizophora mangle 19
Rhododendron surrulatum 379
Rhodomela confervoides 223, 224, 229; f. gracilior 224, 229; subfusca 229
Rhodomenia baerii, nom nud 235; juergensii 235; palmata 219 Pl., 220, 229
Rhynchospora globularis 54
Ribes hirtellum 146; var. calcicola 146
Richards, Edw. L., A New Species of Ratibida (Compositae) from Mexico 267
Robinson, Albert, Jr., An Unusual Erianthus alopecuroides 268
Rogers, C. Marvin, Linum coahuilense, A New Species from Northern Mexico 278; Linum modestum, A New Species from Mexico 406
Rollins, Reed C., Francis Welles Hunnewell, 1880-1964 97
Rubus betulifolius 379; canadensis 149; Chamaemorus 141; elegantulus 149; hispidus 415; idaeus 147, 148, 154; var. aculeatissimus 147, 152; var. canadensis 147, 148; var. **nesophilus** 148; var. strigosus 147; f. tonsus 147, 148; pubescens var. pilosifolius 147; vermontanus 149
Rudbeckia glabra 308; nitida 381; mohrii 381; serecea 380
Rudgea jasminoides 56, 57
Ruellia oblongifolia 379
Ruppia maritima 143; var. longipes 143

Sabbatia foliosa 379; lanceolata 380; paniculata 379
Sabezia humilis 156
Saccorhiza dermatodea 220, 232
Sagittaria graminea 379; mohrii 380
Salix pedicellaris var. hypoglauca 145, 154; pyrifolia 61, 62
Salmea petrobioides 15
Sanchezia and Related American Acanthaceae 313
Sanchezia **arborea** 318, 334 fig., 338; **aurantiaca** 316, 330 fig. 331; **aurea 316**, 329, 330 fig.; **bicolor** 314, 320, 321 fig.; capitata 314, 319; **coccinea** 316, 330 fig., 332; **coleifolia** 314, 317, 321 fig., 322; conferta 317, 336; cyathibractea 314, 319; **dasia** 314, 320, 321 fig.; **decora** 318, 338, 339 fig.; ecuadorensis 318; **ferreyrae** 317, 334 fig., 337; filamentosa 316, 331; flava 315, 324; glaucophylla 324; **habra** 316,

326 fig. 327; **helophila** 315, 325, 326 fig.; hirsuta 323; killipii 316, 327; **klugii** 316, 330 fig., 332; **lampra** 317, 334 fig., 335; **lasia** 317, 334 fig., 336; **leucerythra** 314, 318, 321 fig.; **lispa** 318, 338, 339 fig.; longiflora 317, 335; loranthifolia 318, 341; lutea 318, 340; macbridei 323; megalia 314, 321 fig., 322; munita 315, 325; nobilis 315, 324; oblonga 315, 323; ovata 314, 320; oxysepala 317, 336; parvibracteata 318, 341; parviflora 318, 340; **pedicellata** 317, 334 fig., 336; pennellii 314, 319; peruviana 315, 323, 343; pulchra 315, 325; **punicea** 317, 333, 334 fig.; putumayensis 318, 340; **rhodochroa** 316, 331; rosea 315, 317, 335; rubriflora 315, 325; **sanmartinensis** 316, 326 fig., 328; **scandens** 317, 337; sericea 315, 324; **skutchii** 318, 339 fig., 341; speciosa 315, 324; sprucei 317, 335; var. salvadorensis 341; stenantha 314, 322; **stenomacra** 316, 329, 330 fig.; sylvestris 317, 337, 340; **tarapotensis** 318, 339 fig., 341; thinophila 314, 315, 320; f. glabra 320; f. thinophila 320; tigrina 318, 340; **villosa** 316, 328, 330 fig.; williamsii 316, 332; **woytkowskii** 317, 333, 334 fig.; **xantha** 315, 326 fig., 327

Sanguinaria canadensis var. rotundifolia 312

Sarcomphalus taylori 6

Sarracenia rubra 380

Saxifraga stellaris var. comosa 409

Schkuhria bigelovii 213; biternata 201; multiflora 72 fig., 73, 75, 177, 178, 308, 309; pedata 204; pinnata 177; schkuhrioides 72 fig., 75, 309; woodhousei 290

Schoepfia obovata 12

Schultes, Richard Evans, Plantae Columbianae, XVII, Philodendra Ex Regione Amazoniae Nova 118

Schweinfurth, Charles, Frank C. Seymour and A. F. Hill, Publication Date for the Flora of Stoughton 31

Scirpus setaceus 127

Scoliosorus ensiformis 110

Scoparia dulcis 14

Scutellaria integrifolia 379

Scytosiphon lomentaria 220, 233

Sedum cymosum 90; var. **Smallii** 90; Nuttallianum 90, 91; pusillum 87, 88, 89, 90, 91

Senecio vulgaris 142

Setaria geniculata 380

Seymour, Frank C., A. F. Hill and Charles Schweinfurth, Publication Date for the Flora of Stoughton 31

Sharp, A. J., A New Method for Mounting Evergreen Conifer Twigs with Deciduous Leaves 216; and James S. Pringle, Gentiana austromontana, A New Species from the Southern Appalachians 402

Shinners, Lloyd H., Application of the Name Kuhnia eupatorioides var. angustifolia (Compositae) 160

Silene armeria 54

Sisyrinchium exile 12; micranthum 12

Smilacina racemosa 312

Smilax laurifolia 379

Smith, D. M. and C. B. Heiser, Species Crosses in Helianthus: II. Polyploid Species 344

Smith, Edwin B. Chromosome Numbers in Races of Haplopappus divaricatus 63; and R. Roy Johnson, Microchromosomes in Aphanostephus (Compositae) 270

Smith, Lyman B. and Emery C.

Leonard, Sanchezia and Related American Acanthaceae 313
Solidago canadensis 404, 405; var. canadensis 404, 405 Pl.; microcephala 379; odora 404; rupestris 404, 405 Pl.; stricta 379
Sonchus oleraceus 15
Sophronanthe pilosa 380
Sorbus americana 61; decora 61
Spiraea tomentosa 61, 62
Spiranthes vernalis 379
Sponges, Plant Pressing With Plastic 172
Spongomorpha arcta 233; spinescens 220, 233
Sporobolus teretifolius 378
Stanleya amplexifolia 18, 20, 21, 22, 23
Steele, Frederic L., A Flora of New Hampshire (Review) 411; Potentilla Robbinsiana in the White Mountains of New Hampshire 408
Stellaria calycantha 413
Steirosanchezia scandens 337
Stylesia ambrosioides 208, 209; puberula 208, 209
Styrax pulverulenta 380
Subularia aquatica 127, 128 fig., 130, 131, 133; ssp **americana** 127, 128 fig., 129 fig., 130, 131, 132, 133, 134 Pl., ssp. aquatica 127, 128 fig., 129 fig., 130, 131, 132, 133, 134 Pl.; (Cruciferae), The Genus 127; monticola 127, 130, 133, 134 Pl., 135
Suessenguthia trochilophila 314, 343
Syngonanthus flavidulus 380

Taxodium ascendens 375
Taylor, Constance, and John, Podophyllum peltatum f. Deamii from Bryan County, Oklahoma 167
Tetrorum pusillum 90
Thomas, Joab L. and Rebecca Deramus, The Chromosome Number of Neviusia alabamensis Gray 274
Thespia populnea 13
Tilia neglecta 312
Tillaea ? cymosa 87, 89, 90
Tillandsia Bartrami 20; setacea 20; simulata 20; tenuifolia 20; utriculata 20
Torres, A. M. and J. H. Beaman, The Status of Aganippea bellidiflora (Compositae-Heliantheae) 156
Trailliella intricata 229
Trichophyllum oppositifolium 185, 285
Trichosanchezia chrysothrix 343
Tridax procumbens 15
Trilisa odoratissima 379
Trillium viride 312
Tripsacum dactyloides 11, 371, 372; floridanum 371, 372, 373; Some Observations on the Dissemination of, 371
Tryon, Rolla, Taxonomic Fern Notes, IV. Some American Vittarioid Ferns 110
Turnera subulata 107; ulmifolia var. angustifolia 107. 108; var. elegans 107, 108; var. ulmifolia 107, 108
Typha angustifolia 11, 141; domingensis 11; latifolia 141

Ulothrix flacca 220, 234
Ulva lactuca 220, 234
Urospora workskjoldii 234
Urtica chamaedryoides 312; dioica 312
Utricularia fibrosa 379; macrorhyncha 380; subulata 380; virgatula 379
Uttal, Leonard J., A Hybrid Population of Claytonia in Virginia 136

Vaccinium tenellum 379
Vaccinium myrtilloides 61; Oxy-

Missouri Botanical Garden Library
3 1753 00341 3884

coccus var. intermedium 151; var. ovalifolium 151; var. Oxycoccus 151
Varronia lucayana 8
Vasquezia depauperata 308
Verbena bonarensis 379
Vernonia acaulis 386; altissima 386, 398; × V. angustifolia var. mohrii 399; angustifolia 383, 386, 387, 388, 389, 393, 394, 395 fig., 396, 397; var. angustifolia 386, 388, 389, 392 fig., 395 fig., 396, 397, 398; var. **mohrii** 387, 388, 389, 392 fig., 395 fig., 396, 397, 398; var. pumila 383, 394; var. scaberrima 383, 387, 388, 389, 395 fig., 396, 397, 398, 399; var. texana 383; blodgettii 383, 384, 385, 389, 391, 392 fig., 393, 395 fig.; brevifolia 383, 397; concinna 384, 386, 389, 400; dissimilis 384, 386, 389, 399; fasciculata 383, 396; graminifolia 383, 396; granienifolia 383, 396; missurica 386, 395 fig., 398; noveboracensis 379, 383, 386, 391; ovalifolia 386, 398; × V. angustifolia var. mohrii 400; pulchella 383, 384, 385, 389, 392 fig., 393, 395 fig., 397, 398, 399; × V. angustifolia var. scaberrima 399; pumila 384; recurva 384, 385, 389, 399; scaberrima 383, 384, 385, 386, 389, 397; var. pulchella 398; of the Southeatern United States, Taxonomy of the Narrow-leaved 382; texana 383; × concinna 389, 393, 395 fig., 400; × dissimilis 389, 393, 395 fig., 399; × recurva 389, 393, 395 fig., 398, 399
Viburnum cassinoides 379
Villanova biternata 203; chrysanthemoides 190; dissecta 190
Viola affinis 379; arvensis 34, 35, 36, 38, 39, 40, 41, 42, 43, 44; bicolor 34, 35, 36, 37; eugeniae 43, 44; kitaibeliana 34, 37, 38, 39, 40, 41, 43, 44; var. rafinesquii 37; "kitaibeliana nana", var. nana 41; lanceolata 61, 149, 131; mirabilis 33, 44; odorata 33; pensylvanica, var. pensylvanica 312; pseudogracilis 43, 44; rafinesquii 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44; —, The Only Melanium Violet Native to North America 32; rothomagensis 43, 44; tenella, nom nud 34, 36; tricolor 34, 35, 36, 37, 38, 39, 40, 41, 42, 44; var. arvensis 36
Vittaria filifolia 114, 115; Gardneriana 116; graminifolia 114, 115; latifolia 116; Moritziana 116; Orbignyana 116; remota 116; Ruiziana 116, 117; stipitata 116; vittarioides 116

Wagner, W. H., Jr. and A. Murray Evans, Dryopteris goldiana × intermedia- A Natural Woodfern Cross of Noteworthy Morphology 255
Wallis, Charles S., Erigenia, A Genus New to Oklahoma 311
Warea amplexifolia 18, 20, 21, 22, 23, 24, 25; auriculata 18, 22, 23; carteri 24, 25; cuneifolia 20, 21, 24, 25; (Cruciferae), Nomenclatural and Taxonomic Corrections in 18; sessilifolia 20, 21, 22, 23, 24, 25
Webber, Edgar E., A Rare Blue-green Alga from Massachusetts 163
Wedlia trilobata 15
Westing, Arthur H., Needle Number in Red Pine 27
Wilbur, Robert L., Notes on the Genus Diamorpha (Crassulaceae) 87
Winterringer, Glen S., Notes on Papavar dubium and Camassia angusta 16